International
Space Life Sciences
Working Group

December 27, 1996

Space Life Sciences

Standard Companion Document

1996

A Companion Document
to
Agency Solicitations
in
Space Life Sciences

Issued by:
Life Sciences Division, NASA Headquarters, Washington, DC

On Behalf of the International Space Life Sciences Working Group

SPACE LIFE SCIENCES
STANDARD COMPANION DOCUMENT
1996

TABLE OF CONTENTS

INTRODUCTION

This supplement is a companion to research announcements released by agency members of the International Space Life Sciences Working Group (United States National Aeronautics and Space Administration (NASA), the European Space Agency (ESA), and the space agencies of Canada (Canadian Space Agency, CSA), France (Centre National d'Études Spatiales, CNES), Germany (Deutsche Agentur für Raumfahrtangelegenheiten, DARA), and Japan (National Space Development Agency of Japan, NASDA) for 1997. The various sections of this supplement provide a common basis for proposal preparation and submission by any eligible scientist, regardless of the country of origin.

Interested persons who do not have a copy of the appropriate agency research announcement should contact one of the following persons for more information:

United States National Aeronautics and Space Administration (NASA)	Dr. Joan Vernikos, Director UL/Life Sciences Division NASA Headquarters Washington, DC 20546-0001 USA (202)358-2530 (202) 358-4168 (FAX)
European Space Agency (ESA)	Dick A. M. Mesland, Senior Biologist ESTEC European Space Agency Keplerlaan 1 P.O. Box 299 2200 AG Noordwijk THE NETHERLANDS (31) 71 565 3650 (31) 71 565 3042 (FAX)
National Space Development Agency of Japan (NASDA)	Shunji Nagaoka, Ph.D. Space Experiment Department National Space Development Agency of Japan Tsukuba Space Center Sengen 2-1-1, Tsukuba Ibaraki, 305 JAPAN 81-298-52-2703 81-298-50-2233 (FAX)

Canadian Space Agency (CSA)	Alan J. Mortimer, Ph.D. Program Scientist Space Life Sciences, Space Science Program P.O. Box 7275 Vanier Postal Station Ottowa, Ontario K1L 8E3 CANADA (613) 990-0801 (613) 952-0970 (FAX)
Centre National d'Études Spatiales (CNES)	Dr. Antonio Güell CNES Direction des Programmes 18, avenue Edouard Belin 31401 Toulouse Cedex 4 FRANCE (33) 5-61-28-25-77 (33) 5-61-27-40-13 (FAX)
Deutsche Agentur für Raumfahrtangelegenheiten (DARA)	Dr. Günther Ruyters DARA Head, Life Sciences (WS 2) Koenigswinterer Strasse 522-524 53227 Bonn-Oberkassel Postfach 300364 53183 Bonn GERMANY 49 (228) 447 214 49 (228) 447-714 (FAX)

Proposers submitting responses to agency announcements should be aware that the proposal submission deadline for 1997 is **April 1, 1997**.

1.0 SPACE LIFE SCIENCES PROPOSAL EVALUATION PROCESS

This section describes the process that will be used to evaluate the scientific and technical strengths and weaknesses and, in some cases, the feasibility of carrying out the research/technical plan defined by the proposals submitted to any agency member of the International Space Life Sciences Working Group during early 1997. Following evaluation, each agency will select proposals for either funding or flight opportunities (or both) according to guidelines described elsewhere in individual agency announcements. That selection process is NOT described here.

1.A <u>Evaluation Process</u>

The evaluation process consists of four distinct elements: agency screening, scientific and technical merit evaluation, evaluation of the feasibility of implementing the proposed tasks, and agency evaluation of the relevance of the proposed activity to agency objectives or goals and of resource cost versus availability. All proposals are not necessarily subjected to all four elements of the evaluation process. For example, if an agency has defined a special and restrictive screening process in its announcement, then those proposals that fail to pass that screen will not be subjected to further evaluation. Also, proposals that do not require flight accommodation or the use of special ground facilities to be carried out need not be subjected to the formal feasibility evaluation mentioned above.

1.A.1 Agency Screening

Each research proposal must be submitted to individual space agencies in response to an official agency solicitation issued by that agency. In that solicitation, an agency may define a number of critical constraints that proposals must satisfy in order to be considered for selection by that agency. If this is the case, then proposals not satisfying those constraints may be returned to the proposer without further review. For example, one agency may fund no work with certain specimens, or no work in certain discipline areas, or no work without a flight component. Proposals to these agencies to carry out work that will not be funded by them will be returned to the proposer immediately following submission. For this reason, proposers are advised to communicate with agency officials if there is any doubt of the acceptability of a proposal by the agency in question.

1.A.2 Scientific and Technical Merit Evaluation

Following submission and screening, compliant proposals will undergo a scientific and technical merit review. All compliant ground and flight proposals submitted to NASA will undergo merit review by a panel of US experts. All compliant flight proposals furnished by an agency, as well as US flight proposals, will undergo merit review by a panel of international experts. The variety of panels and the number of experts required for this latter evaluation will be determined by the response to the agency announcements and by the variety of disciplines represented in the proposals received. Experts will, in general, be drawn from the international scientific community. All panels (US and international) will utilize the same factors in their evaluation and all panel meetings will be conducted using the same review guidelines. The aim of this review process will be to determine the scientific and technical value (numerical score plus narrative description of strengths and weaknesses) of each proposal. Cost factors will be considered in this evaluation, but only through determining the appropriateness (realism and reasonableness) of the budget to accomplish the proposed task.

For the purposes of this merit evaluation, scientific proposals will be differentiated from technical proposals by two characteristics: the underlying objective of the proposal and the method proposed for reaching that objective. Scientific proposals generally have, as their primary objective, the development of new knowledge through the scientific method (i.e., through the development and testing of a scientific hypothesis). Technical proposals, on the other hand, usually have the development of technologies or processes as their primary objective, and propose engineering methods, evaluations, and trade studies to reach their objective. It is the responsibility of each applicant to determine whether their submitted proposal is scientific or technical; the central review coordinator reserves the right to reclassify submissions prior to review.

The overall scientific and technical value of each proposal will be based on the following critical factors:

- Clarity of the project's hypotheses and objectives
- Feasibility of the approach and adequacy of the methods and procedures to carry out the proposed project
- Innovation of the research design
- Originality of the proposed project
- Likelihood that the proposed project will lead to new discoveries or fundamental advances within its field
- Likelihood that the proposed project will lead to new technologies that contribute to space missions or to the health and welfare of the people on Earth
- Familiarity of investigators with the relevant published literature
- Background and documented experience and skills of the investigators as an indication of their ability to accomplish the proposed activity
- For flight investigations, documented adequacy of maturity of the proposed project (i.e., is the project scientifically/technically ready for flight or is further ground research or development required?)
- Availability of the investigators to devote adequate time and effort to the project
- Adequacy of institutional resources, facilities, and equipment to support proposed research
- Overall standing among similar proposals available for evaluation and/or evaluation against the known state-of-the-art
- Potential that accomplishing the proposed project will significantly enhance the productivity and/or cost effectiveness of ground or space operations
- Appropriateness of the budget, including the realism and reasonableness of the proposed costs

All proposals evaluated by this merit review will be scored from 0 (minimum) to 100 (maximum) points. The merit score will place the proposal in one of five categories:

Category	Range	Descriptive Features
Outstanding	90-100	This score places the proposal among the top 10% of proposals in its area of research and warrants the highest priority for support. This scoring category is used only for truly outstanding proposals.
Excellent	80-89	This score places the proposal among the top 20% of proposals in its area of research and warrants high priority for support.
Very Good	65-79	This score places the proposal among the top 35% of proposals in its area of research and warrants priority for support.
Good	50-64	This score places the proposal among the top 50% of proposals in its area of research. Proposals in this category are worthy of support.
Fair	0-49	This score places the proposal among the lower 50% of proposals in its are of research. Although support of proposals in this category might be possible with contingencies, generally these proposals should be rewritten and reviewed again prior to support.

In addition, a small number of proposals will not be awarded a numerical score, but will be rated "Not Recommended for Further Consideration (NRFC)." This rating will be given only when the review panel strongly believes that the proposal should not be considered further by an agency. Proposals obtaining this rating will still receive the full attention of the review panel and will be provided the same type of complete narrative critique that other proposers will receive.

1.A.3 Feasibility Evaluation

Following the merit evaluation, each agency will be provided the scores and critiques of the proposals originally submitted to it. Using this information, each agency will then define the set of proposals that are to be subjected to a further engineering and technical evaluation by an international team qualified to determine the feasibility of implementing the proposed projects utilizing available flight and/or ground facilities. The results of this feasibility evaluation will be provided to the agency requesting that it be carried out.

1.A.4 Relevancy And Resource Cost Evaluation

Finally, each agency will determine the relevance of each competitive proposal to its own program. This will be done by evaluating the proposal's contribution to the development of a sound agency program having the appropriate balance of tasks required by the agency's goals and objectives. In addition, this final agency evaluation will take into account the relationship of the proposed cost (and other required scarce resources) to the available funds (and other available resources).

1.B Selection

Following completion of the evaluation process, each agency will prepare a tentative selection plan according to guidelines described elsewhere in individual agency announcements. Then, the members of the International Space Life Sciences Working Group will meet to discuss those issues related to any necessary and appropriate coordination of agency selections that should take place to optimize science return and resource utilization. For example, it may be more efficient or more effective to form international teams of researchers addressing overlapping questions and requiring similar, limited space resources than to have individuals working alone and relatively isolated using closely related research protocols. Experience has shown clearly that such teams are best formed at the time of selection, rather than later in the flight experiment development process.

Following this coordination meeting of the Working Group, each agency will finalize its selection plan and announce its own selections.

2.0 FLIGHT OPPORTUNITIES AVAILABLE FOR SPACE LIFE SCIENCES

Note: The information in this section is repeated from the NASA Research Announcements (96-HEDS-04 and 96-HEDS-05). The relevant portions have been condensed for the international community.

During 1997, proposals for space flight experiments may be submitted in response to the Research Announcement if they involve one of three special types of scientific studies:

A. Short-duration experiments that can be implemented primarily on the Shuttle without the use of major mission resources.
B. Long-duration experiments that can be implemented with the limited resources available on the International Space Station during the early assembly (construction) phase (1999-2000).
C. Pre- and post-mission studies involving tests of the astronaut crew prior to and upon return from their space flight.

All of these experiment types are highly constrained in a number of ways (described below); *proposals requiring resources beyond the capabilities defined below should NOT be submitted in response to the Research Announcement*.

Potential applicants should recognize that, given the limited flight opportunities that are available at present, the flight experiments area is likely to be one of the most competitive arenas within the Space Life Sciences for 1997. It is expected that successful flight experiment proposals will represent mature studies strongly anchored in previous or current ground and/or flight research. Ground-based research may, and often must, represent one component of a flight experiment proposal, but that research should be limited to activities that are essential for the final development of an experiment for flight and for the completion and publication of the scientific results of the experiment. In this case, only one (flight) proposal need be submitted.

Note that all flight experiments must address one or more of the research programs and emphases defined in each agency's Research Announcement. Applicants proposing flight experiments must fill out the information required on Form C (Section 5 of this document). Flight experiment proposals should emphasize the actual experiment, duration requirements, and experiment conditions. The investigator should allow for flexibility in selecting the best hardware to be used to accomplish the experiment goals.

Descriptions of the hardware items available to support human and non-human experiments are included in the International Flight Hardware Catalog section of this document (Section 3.0). Investigators may propose to use one or more pieces of this flight-certified hardware to implement their experiments, or may propose to utilize their own currently existing flight hardware. The development of experiment-unique equipment to implement experiments is discouraged, and individual agencies may not allow such development. However, when exceptional circumstances justify the need for such equipment, such items should be proposed as new developments and the additional costs should be included in the proposal.

It should be noted that the informed consent of human subjects must be obtained prior to carrying out any study in space, and potential proposers should be aware that obtaining such informed consent will involve a uniform process regardless of the country of origin of the proposer.

Applicants should note that flight experiments should be proposed as if the actual flight of the experiment occurred between 1999 and 2001. Experiments that cannot be accomplished within this time period should not be proposed at this time. With strong justification, applicants may request multiple flight opportunities; however, preference will be given to those proposals requesting only one flight to accomplish the proposed research.

2.A Short-Duration Flight Experiments

Short duration experiment proposals submitted in response to the Research Announcement are restricted to experiments that can be accommodated on the Shuttle in addition to the primary mission and that use existing flight hardware. The experiments themselves are usually stand-alone studies that require limited crew training and involvement to execute. It is possible to take advantage of the location in the Shuttle middeck to obtain late pre-flight installation and early postflight retrieval of materials.

For more information on the shuttle middeck accommodations, please access the web site:

http://www.ksc.nasa.gov/shuttle/technology/sts-newsref/stsover-prep.html#stsover-mpaccom

It is expected that a limited number of flight opportunities will exist for the use of human (crew) subjects and non-human subjects. Note that the number of crew subjects available to support such studies will be limited due to both the late manifesting of middeck experiments and the limited amount of crew time historically available to support such experiments.

2.B Long Duration Flight Experiments

Limited research opportunities will be available during the construction phase of the International Space Station. These opportunities shall be longer than the current Shuttle limit of approximately 16 days, but will be constrained in a variety of other ways. Research opportunities will be available during utilization flights when the Shuttle visits the Space Station and during the time period between the utilization flights when the permanent onboard crew will act as experiment operators and, if necessary, as subjects. The duration of microgravity exposure during the 1999-2001 time frame can, in theory, be indefinite with periodic disturbances every 30 days caused by the U.S. and Russian transportation vehicle docking activities. The primary opportunities to transport scientific equipment, supplies, and samples will be on the utilization flights of the Shuttle; however, modest capabilities for research-related deliveries and sample returns will be available on assembly flights that take place every 40-90 days.

During the period of time covered by this solicitation, space life sciences research is restricted to utilize a limited hardware set. Potential applicants should refer to the International Flight

Hardware Catalog section of this document (Section 3.0) for descriptions. The hardware available at this time represents the early configuration of the Human Research Facility and the European Space Agency's Modular Cultivation System.

Applicants should be aware that extravehicular activity (EVA) is scheduled for these flights; this requires the atmospheric pressure in both the Shuttle and the Space Station to be reduced to 10.4 psi for 24 to 48 hours. Proposers should consider the potential impact of such reduced pressure on their investigations. In addition, it is expected that the following resources will be severely constrained throughout 1999-2001: crew availability for science operations, power, and logistics resupply (both frequency and mass) to and from Space Station. Refrigerated stowage on the Shuttle for transport of samples will be very limited, and during certain time frames, refrigerated stowage may not be available on the Space Station. Experiments with few and/or simple in-flight activities have the greatest potential for technical feasibility during this time frame.

It is expected that competitive proposals will address issues of critical basic physiological or operational importance and will require the unique facilities or attributes of microgravity exposure in excess of 16 days for their completion.

2.C Pre- and Post-Mission Studies

Opportunities will be available to perform experiments, collect samples, and take physiological measurements utilizing the astronaut crew both prior to their space mission and following their return to Earth. Such proposals are considered flight experiments and should specify the desired activities, the time frame in which these activities must be performed prior to and following the mission, and the required mission duration (e.g., prior to and following a short-duration shuttle mission versus an ISS mission).

3.0 INTERNATIONAL FLIGHT HARDWARE CATALOG FOR SPACE LIFE SCIENCES

3.A Overview

This document provides information on space flight equipment that is available for applicants to carry out their flight experiments. The hardware described is anticipated to be available for the time frame covered in this solicitation. This suite of hardware represents the contributions of all member agencies of the International Space Station Life Sciences Working Group; all equipment is available for the use of researchers from all member agencies.

Tables 1 and 2 list major and supporting hardware items or capabilities, along with their anticipated availability for short duration and long duration experiments. A detailed description of the items in Table 1 is provided in Section 3.B, and a short description of the items listed in Table 2 is provided in Section 3.C.

Table 1. Major Hardware Item Availability

Major Hardware and Capabilities		
	Short Duration	*Long Duration*
Aerobic Exercise Device - Ergometer	X	X
Aerobic Exercise Device - Treadmill	X	X
Animal Enclosure Module (AEM)	X	
Aquatic Research Facility	X	
Biological Research in Canisters (BRIC)	X	X
Foot-Ground Interface		X
Gas Analyzer Mass Spectrometer		X
HRF Computer Workstation		X
Lower Body Negative Pressure	X	X
Modular Cultivation System		X
Muscle Atrophy Research and Exercise System		X
Plant Growth Facility	X	
Range of Motion Suit (Goniometers)		X
Resistive Exercise Device		X
Ultrasound/Doppler		X

Table 2. Supporting Hardware Availability

Supporting Hardware and Capabilities		
	Short Duration	*Long Duration*
Human Hardware		
Activity Monitor		X
Hand Grip / Pinch Force Dynamometer		X
Hematocrit Centrifuge	X	
HRF Centrifuge		X
HRF Portable Computer		X
Human Physiological Monitoring		X
Blood Pressure	X	X
Muscle Potential	X	X
ECG/EMG/EEG	X	X
Human Sample Collection Kits	X	X
Injection and Infusion System	X	X
Mass Measuring Devices	X	X
Orbiter Centrifuge	X	
Pulse Oximeter		X
Radiation Measurement Capabilities	X	X
Respiratory Impedance Plethysmograph (RIP)		X
Venous Occlusion Cuff and Controller	X	
Video Imaging	X	X
Animal and Plant Hardware		
Beetle Kit Experiment Hardware	X	X
Dissection Microscope	X	
Glovebag Kit	X	X
Harvest Kit	X	X
Fixative Kit	X	X
Flight Syringe Unit	X	X
Temperature Control Devices	X	X

3.B MAJOR HARDWARE ITEM DESCRIPTIONS

HARDWARE ITEM: Aerobic Exercise Device - Ergometer

Equipment Provider: NASA

DESCRIPTION:
The Bicycle Ergometer provides a quantitative measure of the exercise stress induced in a subject. The Ergometer shall be used for crew aerobic exercise.

FUNCTIONAL CAPABILITIES:

The Ergometer shall be capable of:
- Providing a controlled work load, driven by the hands or feet, that is controlled by manual adjustment or computer control.
- Operating in the 0g environment with the subject seated or supine.
- In-flight calibration by a crew member to assure accuracy.
- Providing time-synchronized data compatible with other complementary analyses.
- Providing a measure of external work.
- Accommodating size range of astronaut population from the 5th percentile Asian female to the 95th percentile white male.
- Providing recumbent seating for the user. The seat shall have multiple settings, to adjust to each individual’s comfort.
- Providing a data output which will consist of work rates in watts and pedal speed (rpm) for use with a data acquisition system.
- Being deployable and portable.
- Operating in 1g and 0g environments.

TECHNICAL SPECIFICATIONS:
The Ergometer shall:
- Provide two modes of operations: Manual and Computer Controlled
- Allow selection of the following:
  Work 0 - 350 watts (15 watt intervals)
  Speed 30 - 120 rpm (5 rpm intervals)
- Maintain an accuracy of:
  Workload ±5%, Speed ±3%

RACK CONFIGURATION:
In general, this device may be used with the ambulatory data acquisition system, the mass spectrometer, the foot-ground interface monitor, the holter monitor, the continuous blood pressure measurement device, the pulse oximeter, the respitrace, the video system, the range of motion system, the head and body tracking system, and the hand-load interface and should have close proximity to the above devices.

HARDWARE ITEM: Aerobic Exercise Device - Treadmill

Equipment Provider: NASA

DESCRIPTION:
The Treadmill shall be used for providing walking and jogging exercise. The device will employ various strategies (e.g., subject load devices) to simulate as closely as possible 1g skeletal loading during exercise bouts.

FUNCTIONAL CAPABILITIES:
The Treadmill shall be capable of:

- Providing the proper load distribution on the body similar to that experienced in a variable-g environment. The harness will be adjustable to accommodate the size range of the astronaut population from the 5th percentile Asian female to the 95th percentile white male.
- Providing hand holds for crewmember stability.
- Providing time synchronized data compatible with other complementary analyses.
- Measuring and displaying the loads exerted on the subject by the restraint harnesses prior to, during, and after the exercise bout.
- Measuring and recording the interface loads between the treadmill surface and the foot during exercise.
- Providing a data output terminal to be used with additional data collection systems.
- Providing a control panel display of the following information:

Speed	
Target & Actual distance	Heart rate
Elapsed Time (min:sec)	Restraint Force

- The Treadmill system will provide for manual or software control of device parameters. Software control can be programmed to suit varying exercise protocols. The software required to control the Treadmill system will be resident on the Treadmill.
- Providing the ability to store data from each exercise protocol, and being remotely controlled by a computer.
- The Restraint System shall be capable of providing stabilization of the user in a weightless environment, and proper load distribution on the body and appropriate body orientations.
- The Treadmill should exhibit the following maximum linear and angular displacements following each foot strike:

  Pitch - 5°, Roll - 5°, Yaw - 5°

  Anterior/Posterior - 1 inch, Medial/Lateral - 1 inch, Surface Normal - 1 inch
- The Treadmill shall be capable of accommodating a pattern of medial/lateral foot placement that is consistent with both walking and running on both stable and displacing surfaces.

TECHNICAL SPECIFICATIONS:

The Treadmill shall:

- Provide the following operational modes for exercise:
  - Motor Driven: 0-10 mph, adjustable speed control with speed resolution of 0.5 mph and speed fluctuation less than 2% while the subject is running.
  - Passive: Device will be functional without a motor, and allow a subject to drive the tread at speeds ranging from 2 to 7 mph.
- Loads applied to the harness accelerating the runner towards the treadmill shall be able to be measured and should be between 40-220 lbs. with a load resolution of 5 lbs.

HARDWARE ITEM: Animal Enclosure Module (AEM)

Equipment Provider: NASA

Previous Missions Flown/Status: STS-80 (latest)/Operational

DESCRIPTION:

The Animal Enclosure Module (AEM) supports up to five 250-g rats and fits inside a standard middeck locker with a modified locker door. It is composed of a stainless steel grid cage module, fan blowers, a layered filter system, interior lamps, and a water unit; food bars are glued on cage walls. Total animal floor space, with water box installed, is 645 cm^2. A removable divider plate provides two separate animal holding areas (if required). The AEM remains in the stowage locker during launch and landing. In orbit, the AEM may be removed from the locker and the interior viewed or photographed through the clear Lexan cover which is over the cage; the AEM must be pulled out of the locker approximately three quarters of its depth to allow crew observation of the rodents. Temperature can be read from a built-in thermometer and recorded automatically when the AEM is outfitted with a 4-Channel Ambient Temperature Recorder (ATR-4). The Main Breaker protects and distributes power to fan and lighting subsystems. Additional circuit breakers independently protect lights and fans in diagonally opposed corners to assure light and air circulation on each side of the AEM should one breaker fail. The AEM can be moved into the Orbiter approximately twelve hours before launch and removed approximately one hour after landing.

FUNCTIONAL CAPABILITIES:

Air Quality: Cabin air is exchanged with the unit through a filter system. Four fan blowers, operated by a switch on the front panel, create a slight negative pressure inside the cage, causing an air sweep to pull animal waste products into a collection filter. Cabin air is drawn through the front panel inlet slots, then along the side plenum walls, to be directed though the inlet filter located at the rear of the AEM, into the animal habitat. High efficiency particulate air filters (electrostatic and phosphoric acid treated fiberglass pads) prevent any microbiological escape into the cabin atmosphere. Treated charcoal, within the unit, confines animal odors within the closed system. After exiting the habitat through the exhaust filter (located at the front of the unit between the rodent cage and fans), the filtered air is drawn through the fans into the cabin and directed by the air deflector. Air flow indicator ribbons are attached to both sides of the air deflector for visual confirmation of AEM air flow.

Lighting: The four internal lamps provide an average of 14 lux illumination and are controlled by an automatic timer to provide a 12-hour lighting cycle. The lamps are mounted two to a side in the rear corners of the AEM, between the animal habitat and inlet filter, and are covered with a clear cap to protect each lamp from animal debris. Although the 12-hour cycle is fixed, the starting hours, minutes, and day/night sequence can be selected.

Water: The unit has a 1500- and 2000-cc capacity automatic watering unit that utilizes four “Lixit Drinking Valves” and two flexible plastic (polyvinylchloride) bladders for water storage.

Sufficient water pressure is maintained via compression springs. Total water consumption can be monitored inflight by observation of water levels via a Lexan window on the top of the water box.

Food: Rodent food bars are attached to four slide-in food bar plates inside the rodent cage. The food, a sterilized laboratory formula, is molded into rectangular bars (approx. 1.875 x 1 x 8 inches) accessible to the animals at all times during the mission.

HARDWARE ITEM: Aquatic Research Facility (ARF)

Equipment Provider: CSA

Previous Missions Flown: STS-77

DESCRIPTION:

The Aquatic Research Facility (ARF) is a joint development effort of NASA-Kennedy Space Center (KSC) and the Canadian Space Agency (CSA). The ARF provides a modular, multi-user facility that can be employed to support a wide range of life sciences investigations in microgravity. The ARF system consists of two middeck locker units: the main subsystem and the Sample Storage Unit (SSU). The main subsystem uses 28 VDC orbiter power, while the SSU does not require external power.

FUNCTIONAL REQUIREMENTS:

The heart of the system is the Standard Container Unit (SCU). The SCUs, sized 4.35 inches x 1.188 inches x 3.094 inches, provide a standard interface with the other ARF systems. The inside of the SCU can be customized to meet specific science requirements. The first-generation SCU has been designed to provide automated chemical fixation in a unit which also accommodates on-line video stereomicroscopy. This unit provides two independent 35 ml chambers, each coupled with a 1.1 ml fixative piston. A threaded fitting on the bottom of the chambers facilitates connection of these chambers with the flight syringe unit described below. Three independent containment levels are provided to ensure containment of the fixative solution liquid and vapor. Semipermeable membranes are provided for each level of containment to facilitate diffusion of metabolic gases.

The main subsystem provides a thermally controlled environment of 10°C to 25°C within 0.2°C. The main subsystem provides a 1g and a quasi-static (microgravity) carousel to provide simultaneous microgravity and 1g environments. The 1g carousel supports six SCUs and the microgravity carousel supports up to seven SCUs. Computer-controlled specimen illumination is provided using 660 nm LEDs. The main subsystem supports black and white video observation and recording of specimen activity in both microgravity and 1g environments using an internal Hi-8 video recorder. This video system employs infrared lighting to minimize perturbations to specimen activity and provides a resolution of approximately 100 microns. An on-board computer system controls system temperature, illumination, camera pointing and selection, video recording, and fixation. The computer also records data (i.e., temperature, fixation timepoints, carousel speed, etc.) on non-volatile memory.

The SSU is a passive locker (requires no power) which provides thermally controlled storage for up to 18 SCUs. The SSU occupies a single middeck locker. SCUs located in the SSU can be transferred to and/or from the main subsystem in-flight to provide maximum mission science return. The SSU is designed to maintain a temperature down to 6°C for at least 48 hours. In addition to the thermally controlled storage, the SSU also provides storage space for spare video cassettes, a manual fixation unit, and a main subsystem manual control unit.

HARDWARE ITEM: Biological Research in Canisters (BRIC)

Equipment Provider: NASA

Previous Missions Flown/Status: STS-80 (latest)/Operational

DESCRIPTION:
BRIC is a passive storage enclosure which can be used to transport and house various experiment containers. Since it is passive, BRIC contents are at ambient temperature, and there are no provisions for power or light sources in BRIC. However, it is possible to install a battery-operated environmental data logger (temperature, humidity, pressure) in the BRIC locker. BRIC can be installed into the orbiter middeck during the late access timeframe (~L-16 hours) and removed after landing during early access (~R+3 hours). Investigators may use existing specimen containers (see below) or propose developing unique containers.

FUNCTIONAL CAPABILITIES:

The BRIC canisters are essentially aluminum tubes which provide maximum flexibility in accommodating experiment unique hardware. Hobo data loggers may be included with or in these canisters to provide data recording of temperature, relative humidity, and/or pressure throughout the mission. Three types of containers are currently available:

The BRIC-60 canister is a two-compartment aluminum canister designed to fit inside the gaseous nitrogen (GN2) freezer to enable in-flight freezing of specimens. The BRIC-60 is not sealed. Light traps are provided at the vent ports to permit passive air movement while eliminating light entry to the specimens. Previously flown configurations include eighteen 60-mm Petri dishes or twenty-six Teflon tubes (seed sprouting studies). A total of five BRIC-60 canisters, or two BRIC-60 canisters and one GN2 freezer may be configured in a middeck locker.

The BRIC-100 is a single-compartment, sealed canister. The previously flown configuration includes a stainless steel holder for nine 100-mm Petri dishes. A total of six canisters may be configured in one middeck locker.

The BRIC-100S is a shorter, modified version of the BRIC-100 which includes a quick disconnect lid and ports for gas flushing/sampling. Since this is a sealed canister, the internal gas concentration is independent of the middeck environment. The BRIC-100S can be filled with known gas concentrations pre-flight to support a wide array of investigations. The current configuration supports four 100 mm Petri dishes per canister. A total of twelve BRIC-100S canisters may be configured in a middeck locker.

HARDWARE ITEM: Foot-Ground Interface

Equipment Provider: NASA

Previous Missions Flown: None

DESCRIPTION:
The Foot-Ground Interface is a device which will measure single axis loads, normal to the sole of the foot, between the foot and the supporting surface during any activity in which a crew member engages. In addition to the measurement of total force between the foot and the surface, regional force values will also be available. This device will provide data to the laptop computer and HRF workstation computer for onboard analysis and display.

The flight system will consist of two flexible insole inserts, cables that run from the insoles to the waist along each leg, and a waist pack. The insoles will fit in each of the foot garments of the crewmembers and be connected by cables to the waist pack. The waist pack will contain the signal processing, data storage, and batteries along with control switches and status indicators for battery life and storage capacity. Software will also be provided that will be used to display and analyze the data.

FUNCTIONAL CAPABILITIES:
The Foot-Ground interface shall be capable of:

- Providing a measure of force distribution on the sole of the foot where loading occurs.
- Providing total force measurements normal to the foot sole.
- Generating data in acceptable format and availability for integration into multiple experiment packages.
- Characterizing load profiles via appropriate dynamic response.
- Being worn with suitable footwear that will be used in the Space Station. Sensors should be capable of being worn inside of existing footwear.
- Providing software-selectable regional measurements of the loads applied to six sites: rearfoot, midfoot, medial metatorsal head, lateral metatorsal heads, hallux, and lesser toes).
- Incorporating both “burst mode” and “long-term collection mode” to allow rapid sampling of transient events and long-term sampling and storage at lower frequencies to characterize daily mechanical “dose”.
- Providing insole sizes to suit the variation in the astronaut population.
- Providing a calibration device to verify calibration on orbit or on the ground.
- Providing a data-recording accomplished PCMCIA card for later playback. Real-time display will be provided for calibration and confirmation of operation.
- Providing the software capable of providing pressure distribution or regional force as functions of time.
- On board, simultaneous display of data from the device during data collection.

- Malfunction Indicator. A visual alert indication during setup should be given if there is a fault at any point in the system and identification of faulty elements to prevent them from influencing the measured values.
- Provide interface via RS422 to ADAS, RDAS, HRF Workstation and Laptop Computer.

TECHNICAL SPECIFICATIONS:

The Foot-Ground Interface shall have:

- Accuracy of ±5%. Typical hysteresis of 3%.
- Operational temperature range from 10°C to 40°C.

HARDWARE ITEM: Gas Analyzer Mass Spectrometer (GASMAP)

Equipment Provider: NASA

Previous Missions Flown: Available in December, 1997

DESCRIPTION:
The GASMAP shall be used in conjunction with exercise equipment to measure a person's metabolic activity in a shirt sleeve, intravehicular space environment (18-27°C, 10-80% relative humidity). GASMAP will be capable of providing metabolic data for archival or real-time data downlink to permit investigators at a ground station to monitor data and GASMAP diagnostics. The GASMAP will also be used to support pulmonary measurements and will interface with a pulmonary function/spirometer.

FUNCTIONAL CAPABILITIES:
The GASMAP shall be capable of:

- Monitoring flow of inspired and expired gases. Metabolic activity shall be analyzed by measurement and analysis of the following quantities:
  - Volume of inspired and expired gas
  - Frequency of respiration
  - Ambient barometric pressure and temperature
  - Heart Rate
- Operating on orbit with or without the use of an external laptop computer. A commercially available, MS-DOS compatible computer shall reside inside the gas analyzer and be capable of monitoring and controlling the status of the gas analyzer components and perform gas measurements. It shall also organize the data in such a format that it can be downlinked real time or archived to an external computer. Self-diagnostic software shall be included to facilitate on-board maintenance in space.
- Providing feedback and control of the system via an appropriately sized LCD display and keypad.
- Providing an interface for the gas calibration module for control of that module and calibration gas sampling.
- Providing a filter for the sample inlet system to protect the analyzer from particles that could block the inlet system. The filter shall be accessible from the front panel for easy changeout. The GASMAP shall be capable of giving an indication visible to the user of an inlet blocked condition.
- Handling a varying sample rate through a wide range. The sampling rate shall be programmable. Commercial, well-proven hardware shall be used where practical.
- Updating gas interaction and gaining corrections easily in software. On-board calibration with appropriate gas samples shall be provided, and signal calibrations will be easily updated in software.
- Providing interfaces for heart rate and designated exercise device signals on the front panel for data acquisition. The GASMAP shall be capable of controlling exercise devices via the same interface with programmable or predefined protocols.

- Accommodating two front panel ports for vacuum connection (with the appropriate flow control plumbing). One shall provide a method of transporting a gas sample using space vacuum instead of an internal pump in the event of a sample pump failure. The second shall provide a means to rough out the analyzer using an external vacuum pump or space vacuum, in the event of a loss of vacuum.
- Providing the ability to disable the interaction corrections and/or summing. Under normal operation, the gas analyzer computer corrects interactions between the gases, sums the gas readings and then calculates concentration so that the total of all the gases equals 100%. There are no accuracy requirements for uncorrected readings.
- Providing a flow measurement device which is capable of accommodating the entire respiratory stream as it enters and exits whether the subject is exercising or at rest with a minimum of back pressure.
- Accommodating integration over a single breath to quantify the volume of gas expired, because the composition of the gases within a single breath may vary significantly.
- Providing the proper interfaces to be utilized with the Pulmonary Function/Spirometer system.
- Providing the ability to simultaneously and continuously measure the partial pressures of the individual component gases of a mixture as a percentage of the total pressure of the mixture.
- Providing selected housekeeping parameters for downlink or to auxiliary experiments.
- Displaying information via external computer or front panel LCD in English and Russian.
- Providing limited life components (i.e. batteries, filters, sample line) that are accessible to the user for maintainability. The GASMAP shall also be capable of providing user access to all circuit breakers and/or fuses.

TECHNICAL SPECIFICATIONS:
The GASMAP shall:

- Quantify sampled gases as follows:

TABLE 3.1-1 GASMAP GAS LIST PERFORMANCE SPECIFICATIONS

Gas	Mass Measured (AMU)	Response (10-90%) (ms)	Stability 24-Hour (% of FS)	Linearity and Accuracy FS (% of FS)	Error Allowed (%)	(%abs)
N_2	28	100	± .3	± 1	100	± 1
O_2	32	100	± .3	± 1	100	± 1
CO_2	44	100	± .3	± 1	20	± .2
$C_{18}O$	30	200	± 1.25	± 3	1	± .03
N_2O	30	100	± .4	± 3	10	± .3
Ar	40	100	± 1	± 3	10	± .3
He	4	200	± 1	± 3	10	± .3
C_2H_2	26	200	± .5	± 3	2	± .06
SF_6	127	100	± .5	± 3	10	± .3
N_2	28	200	± .3	± 3	1	± .03

O_2	32	100	± .3	± 1	25	± .25
H_2O	18	???	± .6	± 3	8	± .24

- Have an RS-422 serial port also available to an external computer system of experiment hardware.
- Have an Ethernet Hub, which shall provide communication between the GASMAP and the SIR via its back panel connector. It shall also provide communication between the GASMAP and an external computer for performing detailed system diagnostics.
- Provide a method of switching the measured gas units from percentages of total atmospheric concentration to direct partial pressures and vise versa.
- Provide for display of the analog gas signals along with other major housekeeping functions.
- Provide the capability to measure a minimum of 10 gasses desirable on a breath-by-breath basis.
- Provide a sample gas mixture with a minimum volumetric flow rate of 60 ml/in ±10% via a catheter/capillary tube. Adjustable sample flow rates are required.
- Provide a dedicated high-quality analog, 0-10V DC channel available to external devices on orbit for each specified gas per Table 3.1-1. Not all channels may be active in any one test depending on the selection of gases desired.
- Provide digital data for the selected analog outputs.
- Provide an electrometer capable of sensitivity to 100 ppb.
- The gas analyzer shall be equipped with a turbo-molecular pump of at least 20-50 liters per second pumping capacity to maintain vacuum within the analyzer.
- The Calibration module shall contain gases which provide two calibration points per channel. The calibration subsystem shall exercise each channel at the 10 and 90 percent points.

RACK CONFIGURATION:
The GASMAP and its Calibration Module shall be Standard Interface Rack compatible in both mechanical and electrical fit and function.

HARDWARE ITEM: HRF Computer Workstation

Equipment Provider: NASA

Available Date: August 11, 1997

DESCRIPTION:
The rack-mounted, workstation-class processor and backplane will serve as a general purpose experiment computer. Additionally, the capabilities will support psycho physical/ cognitive/ human factors studies.

FUNCTIONAL CAPABILITIES:
The HRF Computer Workstation shall be capable of:

- Providing high-capacity mass storage devices.
- Uploading and downloading software and data from and to the ground.
- Having sufficient back plane space to support the use of digital signal processing cards and dual 3-D graphics accelerators.
- Supporting multitasking and event-driven, real-time processing.
- Supporting multichannel equal-interval sampling and precise reaction-time measurement.
- Supporting a variety of operating systems, such as DOS/Windows, UNIX/X-windows, and Windows NT.
- Accepting pre-developed software or standard off-the-shelf applications for specific experiment needs (for instance, LabViews, SAMMI).
- Providing simulations of tasks similar to those used in training to measure performance retention/degradation over time and the effect of in-flight training on productivity.
- Accommodating video frame grabbing and NTSC video generator card and video storage capability on disk.
- Providing voice input and sound output.
- Displaying high-resolution graphics. Accepting and utilizing graphics software.
- Providing multiple serial interfaces. Supports a printer.
- Providing Ethernet and Payload Bus connectivity.
- Providing an A/D Card - 16 bit resolution (standard).
- Providing an option to support head-mounted display.
- Providing a Voice Recognition System (software interface required).
- Providing digital sound recording and playing capability.

TECHNICAL SPECIFICATIONS:
The HRF Computer Workstation shall have:

- An adjustable work surface and foot restraints.
- A large (17”) rack-mounted high-resolution, 24-bit color display (standard option) and separate keyboard. The display should have minimum lag, so that dynamic graphics and motion video can be displayed. On/off LCD switching should be less than 100 msec.
- Non-fixed workstation components adjustable and able to connect to seat track attachments.

- Attachments to allow the components to be placed in various orientations or combinations for different test situations.
- Minimum restrictions on the type or quantity of software that may be loaded on the computer.
- Ability to accept wide range of input devices, including trackball, joystick, hand controller, eye-tracker, etc. (Serial port, and Analog input support).
- A PCMCIA slot to access data from other devices stored on PCMCIA cards.
- A file compressor utility program.

HARDWARE ITEM: Lower Body Negative Pressure (LBNP)

Equipment Provider: DARA

Available Date: March 1998

DESCRIPTION:
The Lower Body Negative Pressure (LBNP) Device provides a decompression device for life science research. It will allow scientists to monitor deconditioning of the human cardiovascular system due to long periods of weightlessness and provide for a countermeasure to orthostatic intolerance. The LBNP will accommodate research opportunities such a microneurography for other than cardiovascular discipline science.

The LBNP is a cylinder that encloses the lower abdomen and lower extremities to maintain a controlled pressure differential below ambient during periods of extended weightlessness. The LBNP bag is collapsible. It can be opened via zippers to provide instrumentation of the legs.

Components:

LBNP Device - "Bag" with zippers	Includes waist seals, removable seat, foot rests, relief valve, pump interface, controller interface
LBNP Automatic Controller	Provides pump control to execute science protocols, the unit will be programmable in-flight
LBNP Pump Unit	Decompression source for the LBNP device
HRF Laptop Computer/ HRF Ambulatory Data Acquisition System (ADAS)	Provides waveform display, data storage and interface for data down link
HRF Physiological Monitoring System	Provides ECG and automated ausculatory blood pressure monitoring and analog output during LBNP
HRF Continuous Blood Pressure Device (CBPD)	Provides continuous blood pressure monitoring and analog output during LBNP

Functional and Technical Description:

The LBNP provides pressure applications to the lower body in a range from ambient -60 mmHg ± 1 mmHg using a respective pump system. It allows performance of a continuous decompression to -50 mmHg in the following range: less than 10 seconds, e.g., rapid decompression, and up to 10 minutes, e.g., slow decompression.

The LBNP bag provides a changeable waist seals or an adjustable waist seal to accommodate different crew member waist sizes within the 5 - 95% crew member (male & female) population.

Inside the bag, a system consisting of adjustable foot support, removable saddle, and knee fixation provides skeletal "loaded" and "unloaded" lower body negative pressure. There will be the opportunity for access to the lower extremities such that placement of measurement devices, subject preparation while in the LBNP Device, and signal recording during LBNP is easy and without physical interference (e.g., microneurography). There is also a removable Bioinstrumentation Port.

Electromagnetic shielding of the LBNP Device is guaranteed to allow successful recording of low amplitude, highly sensitive lower body physiological measurements. Sufficient air movement across the subject's legs inside the LBNP Device in order to prevent lower body heating is maintained by the pump system.

The HRF computer system provides a mobile controller close to the subject that will display the following parameters at the LBNP (downlink of data possible):

Vacuum pressure	sample rate: 10 Hz
Stage time	
ECG	sample rate : 512 Hz
Power indicator	
Heart rate	
Blood pressure	sample rate : 512 Hz
- Beat to Beat/Continuous	
- Automated Ausculatory	
Internal LBNP Air Temperature	sample rate: 1 Hz

The controller is capable of executing at a minimum the following: a rapid decompression, e.g., stand test; a continuous ramp protocol, e.g., slow decompression; and a graded ramp protocol, e.g., ramp or stepwise decompressions. The LBNP protocols are programmable in-flight. The capability to pause the execution of a protocol is included.

HARDWARE ITEM: Modular Cultivation System (MCS)

Equipment Provider: ESA

Previous Missions Flown/Status:
In development. Ready for flight in late 1999.

DESCRIPTION:
The MCS is a modular facility for biological experiments composed of a standard cultivation unit and two rotor modules. The cultivation unit provides thermal control, life support, and two drives for 1g reference centrifuges. The rotor modules (diameter 600-mm) will be dedicated to specific classes of experiments and can be exchanged easily on board the space station. The main scientific topics for the initial use of the system are focused on experiments with plants including signal perception and transduction in plant tropisms, plant and insect gametogenesis, development events, and long-term physiological and genetic stability investigations.

The main goal of the development is to provide identical conditions for microgravity, variable-g, and 1g reference experiments. All experimental material is located in experiment containers on the two rotors allowing a simultaneous independent acceleration environment ranging from microgravity (not rotating) up to 2g.

The scientific topics are supported by the development of a plant-oriented rotor system providing accommodation for 6 experiment containers on each rotor. The system allows forced air flow of controlled composition through the container, water resupply, illumination, observation and data acquisition inside the container. The internal dimensions of the containers are 60 mm x 60 mm x 160 mm with the long axis in the g-direction.

A second rotor type under development will accommodate a Confocal Laser Scanning Microscope for on-line observation including intracellular structures on living material as plants and cells under varying acceleration conditions.

It is planned to integrate the facility into an EXPRESS Rack.

FUNCTIONAL CAPABILITIES:
The MCS is a biological facility offering an incubator with drives for two centrifuge rotors as a basic unit. Into this incubator modules (rotors) can be installed using the services of the incubator (power, data, thermal control, drive unit and life support). A first set of rotors dedicated to plant experimentation is under development. The experiment containers also allow the installation of BIORACK hardware (Biorack container inserts).

TECHNICAL SPECIFICATIONS:
- Incubator system with 2 drive units and life support for modular inserts built as rotors (0g to 2g).
- Speed setting independent for both drives.
- Rotor diameter 600 mm.
- Temperature control in the range from 20°C to 37°C.

HARDWARE ITEM: Muscle Atrophy Research and Exercise System (MARES)

Equipment Provider: ESA **Previous Missions Flown**:

DESCRIPTION:
This device measures concentric, eccentric, and isometric strength-isolated joints over the full range of motion of each joint. In addition, the device will be capable of strength training muscles acting across a single joint. The joints of specific interest are the wrist, elbow, ankle, knee, shoulder, hip, and trunk.

FUNCTIONAL CAPABILITIES:
The Strength Measurement Device shall be capable of:

- Strength training and measuring the generated torque during tests on the agonist and antagonist muscle groups of the trunk and extremity joints
- Strength training and measuring the strength during submaximal and maximal isometric, isokinetic concentric, and isotonic (concentric and eccentric) testing of the trunk, hip, and extremity joints throughout the entire range of motion.
- Performing torque angular velocity, and training measurements on the following joint movements. Note that the joints are grouped and the groups are listed in order of importance for testing.
  - Knee flexion/extension
  - Ankle dorsi/plantar
  - Trunk flexion/extension
  - Shoulder flexion/extension; shoulder abduction/adduction; shoulder rotation.
  - Elbow flexion/extension
  - Wrist flexion/extension; supination/pronation; radial/ulnar deviation.
  - Hip flexion/extension. (optional)
- Provide display of peak, torque vs. joint angles, and average torque at specific joint angles as well as torque-velocity throughout the entire range of motion.
- Provide adequate restraining devices for obtaining valid, reliable data by stabilizing the subject and minimizing the influence of other muscle contractions on the measurement.
- Providing for alignment of the device and joint axes of rotation.
- Assessing fatigue over serial contractions.
- Providing a protocol and the software needed for calibration of each measured parameter by the experimenter at each time of use of the apparatus.
- Providing time-synchronized data compatible with other complementary analyses, including other data collected by the data acquisition system, the HRF laptop computer, and the HRF Computer Workstation.
- Providing variable and quantifiable velocities and resistances during training exercises. The velocity and resistive levels shall be changeable on orbit as needed by the subject or experimenter. A menu selection for defining torque, position, and velocity for a series of movements must be available to the experimenter. Use of the menu selection options must be

functionally available to the operator in real time so that a full range of tasks can be programmed. Provide graphic and digital access to all outputs.

- Providing for emergency provisions to terminate any activity on the SMD.

TECHNICAL SPECIFICATIONS:

The Strength Measurement Device shall:

- Provide for measuring torque of and strength training up to 475 Nm (≈350 ft-lb), with an accuracy and resolution of ±2% or better of the measured value ranging from 0 to the maximum torque**.**
- Provide for measuring angular velocity of 0°/sec to 240°/sec, with a resolution of 2°/sec.
- Provide for measuring joint angle of 0° - 180°, with a resolution of 1°.
- Provide for a 20 msec sample rate (50 Hz).
- Provide for time synchronization within 1 msec.

RACK CONFIGURATION:

In general, this device may be used with the ambulatory data acquisition system, the mass spectrometer, the foot-ground interface, the holter monitor, the continuous blood pressure device, the pulse oximeter, the RIP, the video system, the range-of-motion system, and the head and body tracking system.

HARDWARE ITEM: Plant Growth Facility (PGF)

Equipment Provider: NASA

Previous Missions Flown/Status: STS-87

DESCRIPTION:

The Plant Growth Facility (PGF) is a modular facility designed to support investigations using higher order plants. The PGF replaces one middeck locker and operates using 28 VDC orbiter power. Plants are grown in six Plant Growth Chambers (PGCs). Each of these PGCs provides a 4 cm x 18 cm x 6 cm deep growing surface and accommodates plants up to 18 cm in height. All PGC components are sterilizable ,and 0.45 micron air filtration enables aseptic plant growth. The PGCs are equipped with quick disconnect latches to enable easy access to the plant specimens for in-flight photography and/or sampling.

A fluorescent light bank provides a minimum photosynthetically active light intensity of 220 mmol/m^2/sec. The user-defined photoperiod is computer controlled. The system also provides CO_2, temperature, and humidity control. A filter is also provided to remove any ethylene from the air provided to the plants. Data (i.e., temperature, airflow, humidity, irradience, and CO_2) are stored throughout the flight by the system computer. The computer system is battery backed to ensure consistent data archival in the event of power interruptions.

FUNCTIONAL CAPABILITIES:

The following plant growth substrate configurations have been previously flown, but these configurations should be considered suggestive not restrictive:

- Plantlet roots are placed in a Nitex mesh sleeve that is subsequently inserted into slots in Oasis foam . The Oasis foam is saturated with Hoagland's solution to provide water and plant nutrients. This configuration supports good plant growth and provides for easy removal of whole, intact plants with minimal damage to the roots.
- Plants or imbibed seeds are grown in agar-filled polycarbonate centrifuge tubes, which are inserted into an Oasis foam block for structural support. Water may be added to the Oasis foam to reduce agar drying.
- Imbibed seeds are placed in pipette filters which in turn are attached to the top of rectangular polypropylene bags filled with agar. The agar in the plastic bags may be stratified with different nutrients to support optimal plant feeding at different growth periods.

HARDWARE ITEM: Range of Motion Suit (Goniometers)

Equipment Provider: NASA

Previous Missions Flown/Status: Available in July, 1997

DESCRIPTION:
The range of motion suit is a group of instruments designed to measure joint angles. Measurement of these angles provides information critical for detailed analysis of changes in posture and mechanics of movement in space flight. Measurements are made dynamically or at rest. The device will be used with all exercise devices, torque/strength dynamometers, and at workstations and in motion studies throughout the module and will be capable of operation throughout a working day in the station.

FUNCTIONAL CAPABILITIES:
The range of motion suit shall be capable of:

- Providing in-flight, static and dynamic monitoring of: (priority for racks 1/2)
  - Lower Extremity Angles - Hip / 2 Degrees of Freedom (DOF), specifically, flexion/extension, abduction/adduction. Knee / 1 DOF, specifically, flexion/extension; Ankle / 1 DOF specifically, plantar flexion and dorsi flexion.
  - Upper Extremity Joint Angles - Wrist / 2 DOF, specifically flexion/extension and ulnar/radial deviation; Elbow / 1 DOF, specifically flexion/extension. Shoulder / 2 DOF, specifically flexion/extension and horizontal abduction/adduction.
- Generating data in acceptable format and availability for integration into multiple experiment packages.
- Accommodating data rates commensurate with body segment velocities.
- Accommodating data recording on to a PCMCIA card for later playback.
- Accommodating on-board display and recording required to confirm operation, monitor signal nulls, and calibrate all joint angles through the range measured by the system.
- Future development will include 3 DOF measurements of the neck and back, rotation of the shoulder, full range of the sternoclavicular joints (shoulder shrug), forearm rotation, and hip axial rotation.
- Simultaneous joint set measures shall be: wrist/elbow/shoulder and ankle/knee/hip.

TECHNICAL SPECIFICATIONS:
The Range of Motion (Goniometer) shall:

Provide sampling rates from 10 Hz (long term collection mode) to 100 Hz (burst mode) by switch selection.

SPECIAL INTERFACE CAPABILITIES:

- Battery powered for ambulatory use.
- Connector available for rack-powered, tethered operation.

HARDWARE ITEM: Resistive Exercise Device (RED)

Equipment Provider: NASA

Previous Missions Flown:

DESCRIPTION:

The Resistive Exercise Device (RED) provides an additional modality for exercise onboard the ISS. Resistive exercise is important in mitigating the loss of muscle and bone mass that accompanies exposure to microgravity. Multiple joint training is desirable to minimize exercise time required to perform general strength training protocols. The device will quantify for each exercise the total volume of work performed.

FUNCTIONAL CAPABILITIES:

The RED shall be capable of:

- Providing resistance training for the major muscle groups of the legs, thighs, hips, trunk, shoulders, arms, forearms, and wrists.
- Measuring angles, velocities, and forces/torques as a function of time during a specific resistive exercise.
- Providing (1) isometric and (2) isotonic and isokinetic modes of movement, with concentric and eccentric capability for isotonic and isokinetic modes.
- Providing variable and quantifiable velocities and resistances.
- Providing body restraints for the various exercise configurations.
- Providing the ability to be deployed in less than 5 minutes and stowed in less than 5 minutes.
- Providing the ability to measure and control exercise range of motion.
- Providing multi-joint actions to minimize the number of individual movements required to exercise the musculature, thus maximizing exercise efficiency.
- Providing accessible emergency provisions to terminate velocity and/or workload.
- Providing for exercise reconfiguration capability in less than 1 minute.
- Providing for manual and software control capability of device parameters, including uplink and downlink capability of device parameters.
- Providing for manual isotonic concentric operation in case of power failure.
- Providing the ability to record and monitor force/torque and work output.

TECHNICAL SPECIFICATIONS:

The Resistive Exercise Device shall:

- Provide a peak isometric force capacity of 2200 N (≈500 lb).
- Provide an exercise force in a concentric isotonic mode of 25 - 2200 N (≈5-500 lb) at the point of force application, adjustable in 10 N (≈2 lb) increments.
- Provide a linear exercise velocity of 0 to 10 ft/sec, adjustable in 0.5 ft/sec increments; or an angular exercise velocity of 0 to 600 deg/sec, adjustable in 10 deg/sec increments.
- Provide a peak mechanical power of 1700 Watts in the isokinetic mode.
- Provide the ability to be deployed in less than 5 minutes and stowed in less than 5 minutes.

- Provide for exercise reconfiguration in less than 5 minutes.

RACK CONFIGURATION:
In general, this device may be used with the ambulatory data acquisition system, the mass spectrometer, the foot-ground interface, the holter monitor, the continuous blood pressure device, the pulse oximeter, the RIP, the video system, the range of motion system, the head and body tracking system, and PSC and should have close proximity to the above devices.

HARDWARE ITEM: Ultrasound/Doppler

Equipment Provider: NASA

Previous Missions Flown/Status: Available in July, 1997

DESCRIPTION:
This section contains a general hardware description (for reference), and the hardware performance, load, physical (e.g., weight, envelope, etc.), and interface design requirements.

The Ultrasound System is a medical instrument that utilizes ultrasound energy to perform medical imaging and to measure flow rates. The system generates and receives ultrasound signals using hand-held probes. The system contains hardware and software to display and analyze sonographic information. The user controls the software and hardware with a user interface consisting of a keyboard, control switches, knobs and a trackball. The system performs functions to support the following applications:

- Cardiac Ultrasound
- Abdominal ultrasound (deep organ)
- Vascular ultrasound
- Gynecological ultrasound
- Muscle and tendon ultrasound
- Transcranial ultrasound
- Ultrasound contrast studies
- Small parts ultrasound
- Veterinary ultrasound

The physical configuration of the ultrasound system consists of a combination of rack mounted and stowed components. The main electronics unit is a rack mounted assembly that contains the ultrasound system electronics, main electronics power supply modules, and ventilation system. It will be compatible with the Standardized Interface Rack (SIR).

A tissue mimicking test phantom shall be used simulate body tissue and contain standardized targets for checking system performance.

FUNCTIONAL CAPABILITIES:
<u>Ultrasound Operating Modes</u>

- Real Time 2D: The system shall display a two dimensional pie-shaped representation of the internal body structures
- Color Flow Doppler: The system shall display the real time 2-D image with a user assignable color overlay where the color represents the direction of flow
- Color Power Imaging: The system shall display a high sensitivity mode for visualization of small vessels

- M-mode (gray and color): The system shall display a time versus motion plot along user selectable line within the 2-D display
- Pulsed Wave Doppler: The system shall display a Doppler flow graph with audible flow sounds
- Continuous Wave Doppler: The system shall display a continuos wave Doppler flow graph with audible flow sounds
- Dual Image Capability: The system shall be capable of displaying the 2-D image and the M-mode image together to allow for positioning of the M-Mode marker
- ECG Display (triggered 2-D): The system shall have the capability to detect and display the electrocardiograph to be used as a trigger for the 2-D display
- Respiratory Trace Display
- The system shall be capable of being upgraded with 3-D construction capability.

<u>General Physical Features:</u>

- Main Electronics Unit: The main electronic unit is a rack-mounted electronic enclosure. Electrical connections for scanheads, ECG electrodes, control panels, and the display shall be located on the front panel. The main electronics unit shall also provide data interface connectors for video and digital signals. It also shall contain a magnetic optical disk drive and an internal hard drive.
- Video Recorder: A high band 8 mm format video recorder shall be part of the ultrasound system. The video recorder shall be a front loading device with a front control knob.
- Keyboard Module: The keyboard module shall be a portable input device containing the operating controls for the main electronics unit. It includes an alphanumeric keyboard, a trackball, switche, and slide controls.
- Display Module: The display module shall be a portable device that shows text and graphics.
- Ultrasound Probes: The ultrasound probes shall be hand-held devices that can transmit and receive ultrasound energy. They include an integral cable and locking connector.
- Headset: The headset shall be a stereo device used to relay Doppler information to the operator. It shall include an integral cable to interface with the keyboard module.
- Microphone: The microphone shall be a two-piece unit. The signal conditioner shall attach at the user's waist and terminate at the keyboard. The microphone shall connect to the signal conditioner and terminate at the lapel/collar of the user.
- Calibration Standards: The calibration standards shall consist of blocks of uniform materials embedded with objects that serve as imaging targets.
- Consumables: Consumables are accessory items that are used to support ultrasound imaging activities. These items include containers of acoustic coupling gel, packages of ECG electrodes, packages of dry wipes, and 8-mm high-band video tape cassettes.

3.C SUPPORTING HARDWARE AND CAPABILITY DESCRIPTIONS

Human Experiments Support Hardware

ACTIVITY MONITOR

The Activity Monitor is a small wrist- or ankle-worn device which has the capability to simultaneously detect body movement, light intensity, and body temperature. The device is used to evaluate sleep/wake adaptation and circadian cycles. The device can be used to investigate a number of activities such as sleep quality, sleep onset, hyperactivity, as well as other daily routines of human activity.

HAND GRIP DYNAMOMETER/PINCH FORCE DYNAMOMETER

The Handgrip Dynamometer/ Pinch Force Dynamometer (HGD/PFD) is a locker-stowed, hand-held set of components capable of instantaneously measuring hand grip strength or pinch strength as a function of time. The principal components of the HGD/PFD system, as identified below, are: a dynamometer to measure hand grip strength; a second dynamometer to measure pinch strength; a signal conditioner unit to amplify the signal coming from the dynamometers; a laptop computer to display, store, and download the force-time data, as well as to provide the crew with experiment feedback and direction; and associated cables to connect the various components together. Also, a means will be provided for performing on-orbit calibration of the HGD/PFD System.

HEMATOCRIT CENTRIFUGE

The hematocrit centrifuge is a lightweight device which requires 9 microliters of blood for each of 6 capillaries, is hand-held, and battery operated. The hematocrit determinations are read directly off the rotor after approximately 3 minutes of centrifugation. Small amounts of blood plasma can also be obtained. This centrifuge can be used to determine hematocrit during space flight.

HRF CENTRIFUGE

The centrifuge is intended to provide a system for separation of biological samples based on differing sample densities. The centrifuge will be capable of separating blood into its components and is also capable of separating saliva from saturated dental cotton rolls. It will also provide timed centrifugation with selectable centrifugal force while accommodating varying sample sizes.

HRF PORTABLE COMPUTER

The portable computer will consist of a laptop computer, mass storage devices, communication adapters, power supplies and cables, and custom built software. It will use a standard operating system (SOLARIS) and will also be capable of operating software written for Microsoft Windows.

HUMAN PHYSIOLOGICAL MONITORING

Blood Pressure Monitoring

The Manual Blood Pressure Device consists of a sphygmomanometer, with a sewn-in stethoscope as a single unit. The device is exclusively used for determining noninvasive blood pressure in the arm via the brachial artery.

The Automatic Blood Pressure System (ABPS) will be used to measure blood pressure and heart rate noninvasively during rest and during bicycle ergometry or similar exercise.

The Continuous Blood Pressure Device is a portable instrument used to monitor finger arterial pressure. Hydrostatic pressure effects due to relatively slow movements of the hand are compensated by a height correction system. In addition, the Continuous Blood Pressure Device automatically alternates the measurement between two (adjacent) fingers at a pre-determined interval. The instrument can, therefore, be used under many circumstances. For example, the Portapres may be used in conjunction with ECG, respiration monitoring, Holter monitoring, sleep station monitoring, lower body negative pressure testing, and exercise testing.

Combined Blood Pressure Monitoring

The HRF will have the ability to monitor and collect blood pressure data, both continuous and static, on human subjects. The data can be collected by manual or automated methods. The devices can be used in conjunction with other physiological monitoring devices. It is possible to take these measurements during periods of rest and exercise.

Muscle Potential

The Percutaneous Electrical Muscle Stimulator (PEMS) is a high current stimulator which provides trains of pulses of up to 0.8 amps, according to pre-programmed protocols, to stimulate locally the muscles of the human test subject, using reusable, pregelled electrodes.

ECG/EMG/EEG

The HRF will have the capability of acquiring human physiological data, such as ECG, EMG, EEG, temperature, and skin potential response. The data can be collected by means of portable, crew-worn devices over extended periods of time (24 hours) or via rack-mounted devices operated in conjunction with other HRF hardware during periods of sleep, exercise, and other daily activities. These devices have the capability of collecting and storing data for downlink through the HRF data systems.

HUMAN SAMPLE COLLECTION KITS

The sample collection kits consist of blood, urine, and saliva collection kits that are designed to provide collection, preservation, and storage of samples. Tracer kits are included and designed to provide oral ingestion, bolus-injection over a short period of time, or infusion over a designated period to time. The sharp trash container shall isolate, contain, and seal needles, syringes, scalpels, and glass until they can be returned to Earth.

INJECTION AND INFUSION SYSTEM

The injection and infusion systems deliver injections or infuse fluids at a controlled rate. The systems may be used for therapeutic purposes or in support of Metabolic or Pharmacokinetic studies.

MASS MEASURING DEVICES

The HRF will have the capability to measure the mass of the human body, live specimens, plants, solids, semi-solids, and liquids (in containers).

ORBITER CENTRIFUGE

The function of the Orbiter centrifuge is to perform separations inherent in blood-related Life Sciences research. The centrifuge shall provide a minimum relative centrifugal force of 1400-times gravity when fully loaded. There will be an automatic shutdown time that may be manually set for operating durations selectable up to 99 minutes in increments of 1 minute. An override will be available so that manual starting and stopping can be initiated without intervention by the timer. The centrifuge is mounted by two suction cups.

PULSE OXIMETER

The pulse oximeter is a medical device used to continuously monitor the percentage of hemoglobin oxygen saturation in the blood. A noninvasive probe is attached to the subject at locations such as the finger, toe, or earlobe to measure this parameter.

RADIATION MEASUREMENT CAPABILITIES

In order to support the broad range of biological experiment envisioned for the Human Research Facility, a passive dosimeter system with the capacity to provide dose characterization for time intervals as short as one day is desirable.

The passive dosimeter system consists of (1) various radiation detectors packaged in a compact dosimetry-type device, (2) a compact reading and annealing system to determine accumulated exposure of space radiation in flight, and (3) a compact irradiator to calibrate detectors.

Generic instrument set including:

- Personnel Dosimeter(s)
- Radiation Quality (TEPC)
- Spectrometer (charge/energy) - CPDS (SREM - complimentary mode)
- Monitoring/warning
- Environmental monitoring - passive (onboard monitoring (reader/annealer))

RESPIRATORY IMPEDANCE PLETHYSMOGRAPH (RIP)

The Respiratory Impedance Plethysmograph (RIP) has two conductive bands which are placed around the chest of the subject, one around the upper thorax and the other around the lower thorax or abdomen. The bands each form an inductive loop whose inductance depends on the area and material enclosed by the loop. Thus, the subject's respiration creates changes in the area enclosed by the bands, creating corresponding inductance changes. These inductance changes are measured and used to calculate cross-sectional area changes in the chest which, in turn, indicates changes in lung volume. These relative cross-section changes can be used to draw conclusions regarding changes in breathing strategies between 1 and 0 gravity environments.

VENOUS OCCLUSION CUFF AND CONTROLLER (VOCC)

In order to induce a physiological stress on the measured limb, an inflatable venous occlusion cuff will be used. This cuff is electronically controlled. Parameters such as time between inflations and inflation pressure can be controlled. Safety features include: manual start and abort, automatic abort above 235 mmHg, after seven seconds of pumping, and during power loss. The pressure source for the cuff is a battery-powered air pump. The cuff is made to fit the thigh. The cuff controller produces parallel digital data for downlink capability and local display.

VIDEO IMAGING

The HRF will have the capability of documenting Station activities using video and still cameras. Formats will probably be 35mm (positive and negative) and 8mm camcorder.

Animal and Plant Experiments Support Hardware

BEETLE KIT EXPERIMENT HARDWARE

The Beetle Kit hardware was designed to support up to 32 individually housed desert black-bodied beetles (*Trigonoscelis gigas)* for circadian studies. The Beetle Kit is launched in the Shuttle in a middeck locker which is loaded during the late access timeframe prior to launch. If an opportunity exists, the Beetle Kit is also approved for operation on the Russian Space Station Mir. Internal temperature is recorded via an Ambient Temperature Recorder (ATR) for post-flight analysis. Programmable lighting to the beetle activity monitors, which house the specimens, is provided via LEDs operated by the on-board programmable controller. Air exchange is facilitated through periodic (weekly) operation of a small hand-held pump which forces fresh air into the beetle activity monitors. Activity data is recorded and stored in memory for post-flight analysis. Food and water supply are not required. Since the Beetle Kit is flown in the middeck, it may also be retrieved immediately after landing.

Beetle activity is recorded when the specimen moves a turn table which turns a shunt ring through an infrared emitter/detector system. Counts from the detector and the timer are then recorded by data loggers for post-flight analysis. Batteries provide timer circuit, activity monitor, and data logger power for up to 30 days when the kit is not connected to external power. Once specimens are loaded and the kit is closed for flight, no further access is possible or required by the crew.

DISSECTION MICROSCOPE

The Dissecting Microscope may be used to view and video small specimens. It provides for both transmitted and incident illumination and can zoom from 4X to 100X. Samples can be as large as 5 cm in diameter or 8 cm in length. Video is provided through the use of a Charge-Coupled Device (CCD) video camera, and 35mm photographs may also be made.

GLOVEBAG KIT

A portable glovebag is available to support in-flight experiment operations, including fixation procedures. The glovebag provides a temporary hazardous material containment barrier during fixation procedures. The bag is made of clear polyurethane and provides a working area of approximately 2 feet x 2 feet. Rubber gloves are provided to manipulate items in the bag while maintaining containment.

HARVEST KIT

The Harvest Kit is available to provide tools for plant harvesting. Items that are included in the current configuration are forceps (13 mm), scissors (13 mm), micro scissors (9 mm tip), curved dissectors (17 mm tip), pouches, etc. Other items can be included as required.

FIXATIVE KIT

A manual fixative kit can be employed to provide in-flight fixation of specimens. This kit consists of an aluminum box and double-layered polyurethane fixation bags. The fixation bag is approximately 3 inches wide x 12 inches long and is divided up into compartments for fixative and the specimen using three clamps. The current configuration provides a 20 ml fixative volume and a 3 inch x 5 inch area for the specimen.

Operation of the fixative kit consists of placing the specimen into the bag containing the preloaded fixative. Clamps seal the specimen in place. The clamp separating the fixative from the specimen is removed, and the bag is gently manipulated to ensure good contact with the specimen. The fixative bag is then placed in the metal box to prevent inadvertent crushing or puncture of the bag.

FLIGHT SYRINGE UNIT

A flight syringe unit has been developed as part of the Aquatic Research Facility (ARF) project to facilitate transfer of liquids into an sample container unit while maintaining two containment levels at all times. The current configuration provides the capability for precisely metering concentrated solutions (in 12.5 microliter increments) and introducing them into the sample container unit through a 21-gauge hypodermic needle. The syringe is designed to withdraw approximately 1 ml of liquid from the target container to mix with the concentration solution. Mixing is accomplished by cycling the 1 ml fluid volume back and forth into the container. All wetted syringe components are sterilizable. A second syringe configuration is currently under development which will provide double containment transfer of up to 3 ml of fixative.

Temperature Control Devices

The following are descriptions of only some of the refrigerators, incubators, and freezers available for flight experiments. The investigators should specify the temperature requirements for the experiment. The optimum device to accomplish the goals will be identified during the engineering review.

COMMERCIAL REFRIGERATOR/INCUBATOR MODULE (CR/IM)

The CR/IM is an actively powered unit with a temperature range of 4°C to 40°C. It will be used to transport samples/experiments from the ground they are installed in the Incubator on the Space Station. This equipment provides a working volume of 18.7 liters and occupies a single middeck locker. A CR/IM can be operated at a refrigeration temperature from middeck installation to the time the Shuttle is on orbit. As soon as possible after microgravity conditions are achieved, the CR/IM could then be configured to operate at the incubation temperature point. This strategy reduces the amount of time that the specimens would need to be maintained at a reduced temperature. The CR/IMs would continue to incubate the specimens until the specimens can be removed and transferred to the incubators in the Lab.

PASSIVE FREEZER

The Passive Freezer (under development) is planned to be used to transport specimens from the ISS to the ground in the orbiter middeck. The freezer occupies one middeck locker and is expected to provide about 450 ml of -180°C volume. Specimens cannot be frozen using the passive freezer, but must first be frozen in the -80°C on-board freezer.

INCUBATOR

Under development as part of the ISS Laboratory Support Equipment (LSE) complement is a general purpose incubator. In may be used for cellular biology, microbiology, tissue culture, or for any experiment that requires environmental control at biological temperatures. The incubator can only be accommodated in the ISS Laboratory or other on-orbit rack and therefore, is not available for transport to and from the ISS using the Shuttle. It provides approximately 18 liters of conditioned volume between 4° and 38°C (±0.5°C). The incubator provides data to the ISS for downlink and monitoring. Expected availability date for the incubator is around mid-1998.

4.0 SPECIAL INTERNATIONAL GROUND RESEARCH FACILITIES FOR SPACE LIFE SCIENCES

This document provides detailed descriptions of the special research facilities currently available for use by the international scientific community. These facilities are available to investigators for ground research at sites specified in the description. Potential applicants should contact the person identified at the end of each facility description for additional technical information and are cautioned that the cost of using these facilities, as well as the cost of travel to and from the facilities, should be included in any proposal requiring them. Facility use costs should be negotiated and approved by the listed contact person **prior** to proposal submission.

4.A AMES RESEARCH CENTER

1. The Vestibular Research Facility (VRF)

The Vestibular Research Facility (VRF) at Ames Research Center provides unique, state-of-the-art equipment for ground-based studies of vestibular function. It also includes support laboratories and office areas. The VRF houses the following:

- Ground-based multi-axis centrifuge
- 12- Foot linear spring sled
- 30- Foot Sled
- Portable linear sled

The VRF hardware enables the study of responses to smooth, linear motion or to combinations of linear and angular motion over the frequency range of natural head movement. Specific space-related and non-space-related science questions may be addressed. The facility permits the study of how complex linear and/or rotational accelerations are transduced, encoded by the vestibular system, and processed by the brain. Interactions between linear and angular vestibular stimuli, and visual and proprioceptive inputs (peripheral, central and motor) may be examined using electro-physiological, reflex, and behavioral methods. Sensorimotor interactions under complex linear and angular acceleration conditions may be studied systematically.

The VRF ground-based centrifuge was designed to provide each Specimen Test Container payload with accelerations from rotations about two axes simultaneously – the main spin axis and one other high performance axis. If the main spin is not utilized, rotation could occur about a maximum of four axes – both inner and outer high performance axes of both Specimen Test Containers. Currently, only one Specimen Test Container is used to perform experiments; however, the opposite container performs a mirror rotation for dynamic balance. The ground-based centrifuge can accommodate small primates, rodents, and chicks.

The VRF 12-Foot linear spring sled features a highly advanced air bearing system for linear acceleration. It consists of an experimental platform kept 80 millionths of an inch above the test bed. A gimbaled Specimen Test Container is mounted on the platform. Solid support is provided by a 12 foot long block of granite.

The VRF 30-Foot linear sled also features a highly advanced air bearing system for linear acceleration. It consists of an experimental platform kept 80 millionths of an inch above the test bed. A gimbaled chair is mounted on the platform to accommodate human subjects or the 12 foot specimen container to accommodate non-human subjects. Solid support is provided by a 30 foot long block of granite. The 30-foot linear sled can accommodate humans, small primates, rodents, and small chicks.

The Portable Linear Sled (PLS) was developed to utilize air-bearing and new linear motor technology with low vibration at the low end to study the vestibular system in remote locations. It can operate in either the horizontal or vertical positions and has been used in Russia for pre- and post-flight vestibular studies. The PLS can accommodate small primates.

For further information, contact Dr. David Tomko at Ames Research Center, telephone: (415) 604-5723.

2. <u>Human Rated Hypergravity Facilities</u>

Ames Research Center has a suite of hypergravity facilities capable of supporting studies using human subjects and often other species as well. These facilities include a:

- 20-G Centrifuge
- Human-Carrying Rotation Device (HCRD)
- Human-Powered Centrifuge

The 20-G Centrifuge is NASA's only centrifuge currently rated safe for humans. Its three enclosed cabs make it unique among all U.S. centrifuges. One cab contains a modified jet fighter ejection seat in which a human volunteer sits during tests. A second cab, at the other end of the rotating arm, can be configured to meet an investigator's needs. The third cab, located in the center of the centrifuge can also be adapted to the investigator's needs. This cab allows investigators to study variable gravity gradients and can also be used as an on-center control for angular acceleration. A person lying in this cab with the head at the center of rotation experiences different gravity forces on different segments of the body (gravity gradient). The force varies with the distance from the center of rotation. The 20-g Centrifuge can be used to evaluate flight hardware and flight experiment payloads and to test the effects of hypergravity on humans and other animals. The 20-g Centrifuge can also be configured to accommodate rodent and primate subjects.

The HCRD has a 6.5 foot radius and one cab. The cab can be positioned at variable distances from the hub (0 to 6 feet), producing variable gravity levels up to 4.5g. Hydrostatic bearings provide for precise angular accelerations (0.1 deg/sec^2) with a rise time of 0.1 sec. Designed primarily for humans, the HCRD can also support research on rodents, primates, and plants.

The Human Powered Centrifuge was developed as a research tool to provide gravitational forces without exercise or with exercise using only human effort. Currently configured with a pedal mechanism, a variety of exercise methods (stair stepper, rowing, etc.) can be incorporated into the drive system.

For further information, contact Barbara Corbin at Ames Research Center, telephone: (415) 604-3145.

3. Non-Human Hypergravity Facilities

Ames Research Center has a suite of hypergravity facilities capable of supporting studies using non-human subjects and human and/or non-human tissues in addition to those listed above. These facilities include:

- 24-Foot Diameter Centrifuge,
- 8-Foot Diameter Centrifuge, and
- Hypergravity Facility for Cell Culture (HyFaCC).

The 24-foot Diameter Centrifuge is designed to create hypergravitational conditions for small animal and plant research. The centrifuge has 10 radial arms and holds up to a total of 20 large, opaque, ventilated enclosures for holding animals and equipment. These enclosures can be located at different radii to produce gravitational forces of up to four times Earth gravity on the floor of the enclosure. Three additional, smaller enclosures are available near the axis of rotation of the centrifuge, and eight stationary enclosures are available within the centrifuge rotunda to provide appropriate non-hypergravity controls. Onboard water and food dispensing systems permit continuous studies. Slip rings provide in-cage TV monitoring and instrumentation capability. The 24-foot diameter centrifuge can accommodate rodents, guinea pigs, rabbits, primates, and plants.

The 8-foot centrifuge was primarily designed for rodent studies, but can be modified to accommodate other specimens such as small primates. The centrifuge has 10 radial arms, each capable of holding one animal enclosure. The rodent enclosure, similar to that on the 24-foot centrifuge, can accommodate up to two vivarium cages. In addition, special enclosures have been developed to allow centrifugation studies with snakes. These tubular enclosures replace the gimbaled animal enclosures and run parallel with each radial arm. The center of the tube is fixed at a four foot radius.

The Hypergravity Facility for Cell Culture (HyFaCC) is a single arm centrifuge with a 9-foot radius and one Forma Steri-CuH HEPA Filtered Infrared CO_2 incubator. The incubator can be positioned at variable distances from the hub (0 to 9 feet), producing variable gravity levels up to 6g. The HyFaCC was designed to provide the unique opportunity to study the effects of short and long duration hypergravity exposure on cultured cells.

For further information, contact Barbara Corbin at Ames Research Center, telephone: (415) 604-3145.

4. The Biocomputation Center

The Biocomputation Center at NASA Ames Research Center is dedicated to computer-based three-dimensional (3-D) visualization of cells, tissues and organs, to mathematically-based modeling, and to 3-D simulations of the functioning of living systems from the subcellular and molecular to the organismal level. The emphasis is on teams of broadly based, inter-disciplinary investigators and on a union between computational, theoretical, and experimental research. Main facilities include a Zeiss 902 Transmission Electron Microscope and approximately 1,000 square feet of open laboratory subdivided into eight workstation areas.

For further information, contact Dr. Muriel Ross at Ames Research Center, telephone: (415) 604-5757.

4.B JOHNSON SPACE CENTER

1. The KC-135 "Zero-g" aircraft This aircraft, a specially modified version of a Boeing 707, can generate 20- to 30-second periods of microgravity and various levels and periods of hypergravity. This platform can be used to test and validate experimental equipment and new devices to ensure that they will operate properly in varying gravitational fields. Furthermore, since multiple parabolas can be flown, it is also possible to conduct actual experimental studies.

For further information, contact Todd Schlegel, M.D. at Johnson Space Center, telephone: (281) 483-9643.

2. The Human Factors and Ergonomics Laboratory, consists of:

The Anthropometry and Biomechanics Facility (ABF) provides the capability to obtain anthropometric and biomechanical data for use in quantifying human biomechanical capabilities and designing and evaluating human-machine interfaces and tools for current and future NASA manned space flight programs. The ABF supports data collection and analysis in the lab as well as in microgravity simulations of the KC-135 aircraft and the neutral buoyancy facilities at NASA JSC.

The Graphics Research and Analysis Facility (GRAF) provides computer-aided human factors analyses using human modeling integrated with complex environments computer-generated images and animations for interactive graphics analysis of human-machine engineering, systems engineering, flight operations, and Space Transportation System and Space Station design. The facility is also involved in advanced research and development of computational-based analyses and modeling for human factors and human factors engineering topics and issues.

The Lighting Environment Test Facility (LETF) provides technical expertise and tools for the evaluation and testing of luminaires, target materials, and illuminated displays. The facility measures such items as contrast ratios, the bidirectional reflectivity of materials, beam spread distributions and intensities, and spectral distributions of luminaires and materials. The LETF also supports crew training with sunlight, earthshine and nighttime simulations.

The Usability Testing and Analysis Facility (UTAF) provides capability in the area of analysis, design, evaluation, and usability testing of the user interfaces for the work place and work place components. This includes computer display design, cursor controls, glovebox systems, as well as other types of work site interfaces.

For further information, contact Mr. Robert Bond at Johnson Space Center, telephone: (281) 483-3705.

4.C BRANDEIS UNIVERSITY

Slow Rotation Test Facility The slow rotation test facility was developed at Brandeis University to aid in the study of human behavioral and physiological responses to both predictable and aberrant force vectors generated by a rotating environment. The forces experienced under these conditions are very similar to those encountered in space vehicles that rotate to create artificial gravity.

The slow rotation test device is 22 feet in diameter and has a net weight in excess of seven tons. It is driven by a linear induction motor drive designed specifically for this application which has the capability of developing a constant torque of 2,350 ft-lbs. The drive can produce a gravitoinertial force in excess of 4g within the room for a 6,000 pound payload. By means of preprogrammed velocity profiles, the motor drive system can accurately control the rate of speed of the device in either direction over the entire 0 to 35 RPM speed range in increments as small as 1 degree per second squared to ten degrees per second squared increments; constant velocity can be maintained to within $\pm$ .001%. Over the entire speed range z-axis vibration has been measured at <0.001g. The room can also sinusoidally oscillate over a wide range of frequencies.

The control system for this device consists of a time-shared micro-processor that also monitors 280 discrete room safety parameters per second while providing this information to control room personnel. The slow rotation room can accommodate a wide variety of test devices with on-board power for devices requiring either 110 VAC, single phase or 220 VAC, or three phase.

For further information, contact Dr. James Lackner at Brandeis University, telephone: (617) 736-2033.

4.D GROUND-BASED ACCELERATOR FACILITIES

NASA has signed Memoranda of Agreement (MOA) with two ground-based laboratories where energetic beams of protons and high-energy heavy ions are available, in particular, proton beams at the Loma Linda University Medical Center (protons with energies between 70 and 250 MeV) and the Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratory (beams of iron and other heavy nuclei, with energies as low as 1 GeV/nucleon, up to 10 GeV/nucleon). Delivery of beam time at the Brookhaven facility has been directly funded by a contract between NASA and Brookhaven, and similar arrangements are intended for use of the beam time at Loma Linda University Medical Center.

The AGS machine is a US Department of Energy (DOE) facility that is funded by the DOE for research in high energy particle and nuclear physics. Since not all the beam available is actually used for this purpose, Brookhaven is allowed by DOE to provide additional AGS beam time to other scientific users of the machine, as long as operating funds are provided by the sponsor of such proposed work. Use of the Brookhaven facilities requires a separate proposal, which is reviewed by a laboratory-appointed panel and is scheduled in accordance with available beam time and other laboratory resources. Once experiments are approved, they are required to satisfy the normal process of preparation for running at the AGS, which includes familiarization with AGS rules and policies (safety being the paramount consideration among these), and registration with the laboratory as a guest scientist.

User facilities have been developed at Brookhaven for radiation biology research, including cell cultures and small animals. These include the shielding cave containing the beam, the biological experiment station, and laboratory space and animal facilities in the Brookhaven Medical Department. A 10-foot long optical bench for sample exposures is available in the cave, as well as beam handling, sample changing and dosimetry instrumentation. The biological experiment station contains one area for cell culture equipped with a laminar flow hood and incubator, one short-term animal holding facility, and one area for physics/run-control use. In addition, laboratory space and access to AAALAC-accredited animal facilities, subject to standard use charges, are available in the Medical Department. Brookhaven also has on-site housing accommodation for users (dormitory and apartment-style units), a cafeteria, an automobile service station, and travel and post offices. Scientific personnel are available to assist users.

A first experimental run, using 100 hours of beam time delivered to experimenters over a 2-week period, was completed successfully in 1995. The next run, of similar duration, has been scheduled for the Fall of 1996. Beams with energies as low as 1 GeV/nucleon have been extracted, with circular beam spots of up to 16 cm diameter, center-to-edge uniformity of 15%, and dose rates up to 11 Gy/min. Investigators currently funded by the NASA program participate in research using these beams, and coordination of beam use with these investigators and institutions is actively encouraged. In particular, a physics and dosimetry group is available for investigators requiring their assistance.

It is expected that similar arrangements, taking advantage of existing in-house expertise, will be negotiated with Loma Linda University Medical Center, in the framework of the MOA with that institution.

For further information contact the following:

Brookhaven National Laboratory

Dr. Marcelo Vazquez
e-mail: vazquez@image.bio.bnl.gov
or
Dr. Betsy Sutherland
Biology Department
e-mail: betsy@image.bio.bnl.gov
or
Dr. Phil Pile
AGS Department
e-mail: pile@bnldag.ags.bnl.gov

Brookhaven National Laboratory
PO Box 5000
Upton, NY 11973-5000

Loma Linda University Medical Center

Dr. Gregory A. Nelson
Jet Propulsion Laboratory, MS 89-2
4800 Oak Grove Drive
Pasadena, CA 91109
e-mail: Gregory.A.Nelson@cc2mhb.jpl.nasa.gov

4.E MICROGRAVITY USER SUPPORT CENTER, KÖLN, GERMANY

The DLR Microgravity User Support Center (MUSC) is the German user support center for research under space conditions. The MUSC is equipped with laboratory infrastructure, simulation facilities, experiment control rooms, user rooms for science monitoring and data evaluation, a user information area with a microgravity library, and the information system ARIADNE. Further equipment and laboratories are located in the Institute of Aerospace Medicine. The Institute of Aerospace Medicine set up a unique infrastructure now offered for application in an international scope of space biology and human physiology research, offering support for ground-based research and small payloads in the scope of a joint interagency research program for cell and molecular biology, systems biology, plant biology, botany, and zoology.

For 0g simulations, hypergravity experiments, and extended ground-based research, the following infrastructure and facilities can be utilized for integrated investigations in the above mentioned fields of research:

- Fast rotating clinostats **with online microscopic observation**
- Cuvette clinostats
- STATEX **incubator for small petri dishes with reference centrifuge**
- BIOLABOR double rack (DARA hardware)

- Slow Rotating Centrifuge Microscope (NiZeMi lab model**, up to 5g**)
- Cultivation chambers for Biorack containers Type I and NiZeMi
- Different centrifuges including large centrifuge
- Large-scale Magnetic Resonance device **for biological and biomedical investigations** (imaging, microscopy, and spectroscopy)
- Tilting microscope
- Data and image processing capabilities
- Computer-based fluorescence microscopy (Zeiss Attofluar)
- Laboratories and sophisticated workshops also for electronics

For further information, contact Dr. Marianne Schuber, Microgravity User Support Center - MUSC, German Aerospace Research Establishment (DLR), Institute for Aerospace Medicine, Linder Höhe 45, D-51147 Köln, Germany. Telephone: (49)-2203-601-0 , Fax: (49)-2203-696-212,
e-mail: Marianne.Schuber@dlr.de

4.F RESEARCH FACILITIES IN TOULOUSE, FRANCE

1. Clinical Research Facility

The Clinical Research Facility (CRF) is a 1000m^2 (10,700 square feet) multi-purpose facility located within the Toulouse Rangueil Hospital. It is operated by MEDES (Institut de Médecine et Physiologie Spatiales), a subsidiary of the French Space Agency, Toulouse Hospital, the French Atomic Energy Commission, and several universities and research centers.

It has been designed to host most of the ground-based clinical or human factors experimental research necessary to conduct space research, for instance:

- simulation of effects of the space environment (bed rest, confinment, circadian rhythms, etc.)
- performance of experiment verification tests or control experiments
- testing of equipment or procedures
- medical screening and check-up for healthy volunteers
- training courses of students and hosting of Ph.D. students

CRF has access to the biomedical facilities of a high standard hospital (NMR, CT scan, biological analyses). Its internal equipment includes the main required devices:

- to test and monitor specific physiological functions (LBMP, tilt table, rotating chair)
- to handle biological samples

It allows monitoring of the main environmental parameters or parameters linked to the subject such as:

- diet
- activity (24 hour video monitoring)
- temperature 2° to 25°C±0.5°C
- acoustics (isolation of 60dB from external environment, background less than 35dB)
- lighting (natural/artificial ranging from 0 to 500 Lux)

CRF capacity ranges from:

- 4 beds for strictly controlled sleep or alertness studies, enabling blood sampling and physiological recordings without disturbing the patient
- 6 beds for strictly controlled sleep or alertness studies
- up to 26 beds for miscellaneous tests

CRF is served by highly skilled professionals matching the requirements of good clinical and good laboratory practices. Services will be strictly tailored to the needs of the investigators. They can be limited to a simple logistics accomodation, hosting of researchers, and the coordination of international multicentric studies.

For further information, contact Dr. Anne Pavy le Traon, Clinique de l'Espace,
1 avenue Jean Poulhes, 31054 Toulouse Cedex, FRANCE
Telephone: 33-62-17-49-50
Fax: 33-62-17-49-51
e-mail: Anne.Pavy-Le.Traon@cst.cnes.fr

2. Parabolic Flights
   Airbus A 300

Parabolic flights present an interest for the scientific users, industry, and Space agencies due to the reduced costs, the operational, and the possibilities to receive technical teams which design space experiments.

The main domains are:

- research in microgravity conditions (life sciences, physical sciences)
- research in technology
- ergonomy and security, procedures, etc.

The parabolic flight campaigns are organized by NOVESPACE, which is a CNES subsidiary.

Two types of campaigns can be organized:

- The standard campaigns: Three flights of 30 parabolas each (1 flight per day). About 15 different experiments can be accomodated, and 35 to 40 people can participate.
- Specific campaigns during which a unique user can choose the number of flights, their duration, and their profile. This approach can be organized from Bordeaux, France or from anywhere in the world.

During the 20 to 25 seconds of the parabolic maneuver, the level of residual gravity is between -2.10^{-2}g and $+2.10^{-2}$ on the z axis, between -10^{-2}g and 10^{-2} on the x axis, and between -10^{-3}g and 10^{-3}g on the y axis

The cabin dimensions are 20m long x 5m wide x 2.40 m high. The total volume is $300m^3$. The cabin pressure is 300 mb and the inside temperature is 20°C.

For further information, please contact Monsieur Denis Thierion, CNES,
18 avenue Edouard Belin, 31055 Tolouse Cedex, FRANCE
Telephone: 33-61-27-32-48
Fax: 33-61-28-21-65
e-mail: denis.thierion@cst.cnes.fr

3. <u>Center of Assistance for the Development of Microgravity Operations in Space (CADMOS)</u>

The CADMOS, located at the Toulouse Space Center, was created in 1991 in order to provide technical and operational support to scientific users in the field of microgravity sciences. It includes various laboratories and a control center which are described below.

Technical Support:

The CADMOS provides means to perpare experiments in the field of physiology and biology. The CADMOS is equipped with laboratory areas including ground model facilities and test benches. The following instruments are currently available:

- **Physiology**

  PHYSIOLAB (cardiovascular physiology)
  COGNILAB (sensorimotor physiology)

- **Biology**

  FERTILE (amphibian development)
  IBIS (cellular biology, development)

These instruments can be used for ground-based studies and for pre- and post-flight investigations. A user information area is also implemented with microgravity experiments and facilities documentation, vehicle information documentation, an archive, and a user database.

Operational Support:

The CADMOS control center provides means for remote control of space experiments. This control center has already been used during several missions, including shuttle flights (LMS mission, July 19 and Shuttle-USMP missions) and MIR missions (EUROMIR'94, French missions in 1992, 1993, and 1996). Information from space is made available to the scientists on the ground via audio and video link, as well as telemetry. Telescience capabilities can also be used.

The CADMOS is equipped with a specific control room, a private video-conference room, user rooms for data monitoring and evaluation, technical premises, and reception and meeting rooms. These technical and operational supports are located in the same building.

For further information, please contact Alain Desroche, CNES/CT/ED/MV/CA, Bpi 2221, 18 avenue Edouard Belin, F-31401 Toulouse Cedex 4, FRANCE, Telephone: 33-5-6128-2623, Fax: 33-5-6128-2165

5.0 INTERNATIONAL APPLICATION FORMS AND INSTRUCTIONS FOR PROPOSAL PREPARATION

This section contains the general instructions for proposal preparation and the specific forms required by proposers responding to agency solicitations in the space life sciences for 1997. The forms at the end of this section include the following:

Agency-Independent Forms

Form A	Solicited Proposal Application
Form B	Proposal Summary
Form C	Space-Flight Experiment Supplementary Application Information (Optional)
Form D	Checklist for Proposers
Form E	Multinational Space Station Human Research Informed Consent

Agency-Specific Forms

National Aeronautics and Space Administration (NASA)

Form US-1	Program Applicability
Form US-2	Detailed Budget, First Year
Form US-3	Detailed Budget, Entire Project Period
Form US-4	Certification Regarding Drug-free Workplace Requirements
Form US-5	Certification Regarding Debarment, Suspension, and Other Responsibility Matters
Form US-6	Certification Regarding Lobbying

Instructions for Proposal Preparation

The information contained in these instructions is specific to this Announcement and supplements the general guidance provided in Appendix B.

All U.S. proposals should include one copy of each of the forms provided in this Appendix as part of the complete submission, with the exception of Form C that is submitted only with flight experiments. Non-U.S. proposals with no U.S. component are not required to submit Forms US-1, US-2, US-3, US-4, US-5, or US-6.

The proposal should include the following material, in this order:

(1) Transmittal Letter
(2) Cover Page: Solicited Proposal Application (Form A)*
(3) Proposal Abstract (Form B)
(4) Detailed Budget, 12 Month (Form US-2)
(5) Detailed Budget, Entire Project Period (Form US-3)
(6) Proposal Title Page, with Notice on Restriction on Use and Disclosure of Proposal Information, if any
(7) Project Description
(8) Space Flight Experiment Supplementary Application Information (to be submitted with flight experiments only) (Form C)
(9) Management Approach
(10) Personnel
(11) Facilities and Equipment
(12) Supporting Budgetary Information
(13) Special Matters (specific information on animal and/or human subjects protocol approval required, if applicable)*
(14) Certification Regarding Drug-Free Workplace (Form US-4)*
(15) Certification Regarding Debarment, Suspension, and Other Responsibility Matters (Form US-5)*
(16) Certification Regarding Lobbying (Form US-6)*
(17) Computer diskette (3.5 inch, Macintosh or PC format) containing an electronic copy of the principal investigator's name, address, telephone and Fax numbers, e-mail address, and the complete project title and abstract as provided on Form B
(18) Checklist for Proposers (Form D)
(19) Appendices, if any

* One signed original required

Except for the Project Description Section, there is no specific page limitation on proposals submitted. However, every effort should be made to keep proposals as brief as possible. The name of the Principal Investigator should appear in the upper right hand corner of each page of the proposal, except on the Forms in this Appendix where special places are provided for this information. Note that the proposal must specify the period of performance for the work described; periods of performance may be for any duration up to four (4) years but should be suitable for the project proposed.

(1) Transmittal Letter

The transmittal letter should contain, at least:

- (a) The legal name and address of the organization and specific division (or campus identification if part of a larger organization) that proposes to carry out the project
- (b) A brief project title intelligible to a scientifically literate reader and suitable for use in the public press
- (c) The name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation
- (d) The identification of the specific NRA, by number and title, to which the proposal is responding
- (e) The signature of the responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization

A copy of the Checklist for Proposers (Form D) should be attached to this letter. Only one copy of the transmittal letter is required; it should be attached to the single original signature version of the submitted proposal.

(2) Cover Page: Solicited Proposal Application (Form A)

The information on Form A must be filled out completely, and one original signature version of this form should be submitted with the transmittal letter above.

For Item (7) on this form, new means that a proposal for this project has not been submitted to NASA in 1995 or 1996, renewal means that this proposal is for the continuation of an already funded task beyond the term of the funded proposal, and revised means that this proposal represents a revision of a proposal submitted to NASA in 1995 or 1996, but not funded. A proposal previously submitted but not funded should be termed revised even if the original principal investigator has changed for 1997. Renewal and revised applications should contain special material described in the Project Description section, below.

Note that items (9) and (10) on Form A require assurance of compliance with human subject and/or animal care provisions of NASA regulations (see Special Matters section, below).

Applicants should be aware that review of a proposal will not be undertaken without prior assurance of compliance.

(3) Proposal Abstract (Form B)

The information requested on this form is essential to the review of the proposal. It determines how the application will be evaluated and which program manager(s) will receive the final review materials for possible inclusion in one of the research programs of the Division. Applicants are requested to classify their proposals as either scientific or technical. Scientific proposals should be differentiated from technical proposals by two characteristics – the underlying objective of the proposal and the method proposed for reaching that objective. Scientific proposals generally have, as their primary objective, the development of new knowledge through the scientific method (i.e., through the development and testing of a scientific hypothesis). Technical proposals, on the other hand, usually have the development of technologies or processes as their primary objective, and propose engineering methods, evaluations, and trade studies to reach their objective.

(4) Detailed Budget, 12 Month (Form US-2)
(5) Detailed Budget, Entire Project Period (Form US-3)

These forms are self-explanatory budget forms that must be submitted with each U.S. proposal, or with non-U.S. proposals that have a U.S. component for which NASA funding is sought.

Foreign proposals with no U.S. component should not submit these forms but, as explained in Appendix A, should be endorsed in writing by the respective government agency or funding/sponsoring institution in that country from which the non-U.S. participant is proposing. This endorsement should indicate that:

(a) The proposal merits careful consideration by NASA, and
(b) If the proposal is selected, sufficient funds will be made available to undertake the activity as proposed.

(6) Proposal Title Page, with Notice on Restriction on Use And Disclosure of Proposal Information, If Any

The title page should contain the project title, name and address of the submitting institution, the name, address and telephone number of the Principal Investigator, and the names and institutions of any co-investigators. It is NASA policy to use information contained in proposals for evaluation purposes only. While this policy does not require that the proposal bear a restrictive notice, offerors or quoters should, in order to maximize protection of trade secrets or other information that is commercial or financial and confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting appropriate identification, such as page numbers, in the notice. In any event, information (data) contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

NOTICE

Restriction on Use and Disclosure of Proposal Information

> The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(7) Project Description

The length of the Project Description section of the proposal should not exceed 25 pages using regular (12 point) type. The proposal should contain sufficient detail to enable a reviewer to make informed judgments about the overall merit of the proposed research and about the probability that the investigators will be able to accomplish their stated objectives with the resources requested and with their own resources. In addition, the proposal should indicate clearly the relationship between the proposed work and the research emphases defined in this Announcement. The project description should be consistent with the type of proposal that is being submitted (ground-based research investigation or space flight experiment). If an investigator wishes to propose related studies of two different types (e.g., a ground-based research investigation and a related space-flight experiment), then two proposals should be submitted with their linkage described in each proposal.

Renewal applications (for competing renewal of currently funded activity) must include a progress report as an Appendix to the proposal, and should refer to this Appendix appropriately throughout the Project Description section.

Revised applications (revisions of 1995 or 1996 submissions) must include, as part of the Project Description section, an **Introduction** that contains responses to the criticisms in the previous critique. Applicants should highlight the changes they have made in their research plan by appropriate bracketing, indenting, or changing of typography. Clearly present any work done since the prior version was submitted. Note that revised applications that do not address the criticisms in the previous critique and/or include substantial revisions may be penalized in the review process.

(8) Space Flight Experiment Supplementary Application Information (Optional, Form C)

All applicants proposing space flight research should complete Form C. The information on this form is essential for the evaluation of the feasibility of carrying out the proposed study. Before filling out this form, applicants should read Section 2.0 of the *Space Life Sciences Standard Companion Document 1996* carefully and make certain that they understand the accommodation constraints that are associated with flight experiments. In addition, applicants should utilize available equipment to implement the proposed experiment (as listed in Section 3.0 of the companion document), or should provide a low-cost available alternative. Failure to do this may preclude implementation of the experiment.

(9) Management Approach

Each proposal must specify a single principal investigator who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. In proposals that designate several senior professionals as key participants in the research project, the management approach section should define the roles and responsibilities of each participant, and note the proportion of each individual's time to be devoted to the proposed research activity. The proposal should state clearly and unambiguously whether these key personnel have reviewed the proposal and endorsed their participation.

(10) Personnel

The principal investigator is responsible for direct supervision of the work and participates in the conduct of the research regardless of whether or not compensation is received under the award. A short biographical sketch of the principal investigator that includes his or her current position title and educational background, and a list of principal publications and any exceptional qualifications should be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(11) Facilities and Equipment

Describe the available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any government-owned facilities, industrial plant equipment, or special tooling that are proposed for use on the project. Provide evidence that such facilities or equipment will be made available if the applicant is successful in obtaining funding. Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative to purchase. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for both research and non-research purposes should be explained.

(12) Supporting Budgetary Information

This section should include the supporting information required by Forms US-2 and US-3. In this NRA, the terms "cost" and "budget" are used synonymously. Sufficient proposal cost detail and supporting information will facilitate a speedy evaluation and award. Dollar amounts proposed with no explanation (e.g., Equipment: $1,000, or Labor: $6,000) may cause delays in evaluation and award. Generally, NASA will evaluate costs as to reasonableness, allowability, and allocatability. The budgetary forms define the desired detail, but each category should be explained in the body of the proposal. Offerors should exercise prudent judgment in determining what to include in the proposal, as the amount of detail necessarily varies with the complexity of the proposal.

The following examples indicate the suggested manner to prepare a cost breakdown.

Direct Labor

Labor costs should be segregated by titles or disciplines with estimated hours and rates for each. Estimates should include a basis of estimate such as currently paid rates or outstanding offers to prospective employees. This format allows the Government to assess cost reasonableness by various means including comparison to similar skills at other organizations. Example:

	Hours	Rate	Amount
Principal Investigator	100	$19.34	$1,934
Co-Investigator	450	$11.78	$5,301
Clerical Support	75	$ 8.70	$ 652
Total	625		$7,887

Indirect Costs

Indirect costs should be explained to an extent that will allow the Government to understand the basis for the estimate. Examples of prior year historical rates, current variances from those rates, or an explanation of other basis of estimates should be included. Where costs are based on allocation percentages or dollar rates, an explanation of rate and application base relationships should be given. For example, the base to which the General and Administrative (G&A) rate is applied could be explained as: application base equals total costs before G&A less subcontracts.

Other Costs

Each significant cost category, such as travel, should be detailed, explained, and substantiated. Past experience has indicated that up to six trips may be necessary for a flight experiment. (i.e., Crew Familiarization (Johnson Space Center, JSC), pre-flight Science Verification Test (Kennedy Space Center, KSC), L-14 day Press Briefing (JSC), Mission Preparation/Operations (KSC), Post-Flight Ground Control (KSC), Post-Flight Results Symposium). Format should be as follows:

Travel Costs

Destination	Duration	Airfare	Per Diem	Total
Moffett Field, CA	3 days	$500	$300	$800
Washington, DC.	1 day	$500	$100	$600
Total				$1,400

If the proposal is for competitive renewal of an ongoing research effort beyond the present period of approval, the proposal cost section should include an estimate of any significant amount of unspent or uncommitted funds remaining at the completion of the current period of performance.

The supporting budgetary information section of the proposal should include information concerning other current projects being conducted by the Principal Investigator and funded either by NASA or any other Government agency.

Provide the title of project, the sponsoring agency, the project period, the investigator's time commitment, and the value of the project. The following format is recommended:

Funding Organization	**Title**	**Number**	**Total Project Period**	**Total Effort**	**Direct Costs**
NIH	Bone Mineralization	R01 NS 01234-06	12/89-11/94	30%	$100,000
NSF	Osteosclerosis	DRF 7683-05	6/90-5/93	10%	$20,000

(13) Special Matters

The Special Matters section must contain a statement from the proposer's institution which states that the proposed work will meet all Federal and local human subject requirements and animal care and use requirements, if applicable. Note that no animal subjects may be utilized unless specific information justifying and describing their use is included in the proposal. Policies regarding the protection of human research subjects in NASA-sponsored research are detailed in NASA Management Instruction (NMI) 7100.8B (Protection of Human Research Subjects), and animal care and use requirements are detailed in the NASA Code of Federal Regulations (CFR) 1232 (Care and Use of Animals in the Conduct of NASA Activities), both of which are available from the Life Sciences Division, Code UL, NASA Headquarters, Washington, DC 20546. Assurance of compliance with human subject and/or animal care provisions is required on Form A, to be submitted with each proposal. In addition, a letter signed by the chairperson of the Institutional Review Board (IRB) or institutional Animal Care and Use Committee (ACUC) or both, as appropriate, regarding approval of the experimental protocol, should be included with each copy of the proposal. All non-NASA proposals providing ACUC approval must also contain the institution's Public Health Assurance number. All non-US proposals should provide certification from the investigator’s institution stating that the proposal has been reviewed and approved to be compliant with international regulations on bioethics standards for the use of animals or humans in research. Applicants should note that this is a strong requirement: **Review of the proposal will not be undertaken until this information is supplied to NASA.**

NASA is a participating agency for the “Presidential Early Career Awards for Scientists and Engineers.” NASA will select its Awardees based on exceptionally meritorious proposals funded through the traditional grants process, including this NRA. Awardees must be U.S. citizens, nationals, or permanent residents who have received their highest degree within five years.

(14) Certification Regarding Drug-Free Workplace (Form US-4)
(15) Certification Regarding Debarment, Suspension, and Other Responsibility Matters (Form US-5)
(16) Certification Regarding Lobbying (Form US-6)

These three certifications are required of all U.S. applicants before a grant/contract can be awarded. They are not required of foreign proposals with no budget section.

(17) Computer Diskette (3.5 Inch, Macintosh Or PC format) containing an electronic copy of the Principal Investigator’s name, address, telephone and fax numbers, e-mail address, and the complete Project Title and Abstract as provided on Form B

Self-explanatory.

(18) Checklist for Proposers (Form D)

One copy of a completed version of this checklist should be attached to the transmittal letter.

(19) Appendices, If Any

Renewal applications (for competing renewal of currently funded activity) must include an Appendix providing a Progress Report of the previously funded activity. That report should give the beginning and ending dates for the period covered since the project was last reviewed competitively and provide a list of all personnel who have worked on the project during this period (including dates of service and percentages of their appointments devoted to the project). The report should also summarize the previous project's original goals and specific objectives and provide a succinct account of published and unpublished results indicating progress toward their achievement. Changes in these objectives during the course of the project and a rationale for these changes should be presented. The importance of the findings should be summarized and discussed. Finally, a list should be provided of the titles and complete references to all publications, manuscripts submitted or accepted for publication, patents, invention reports, and other printed materials that have resulted from the project since it was last competitively reviewed.

Other Appendices may be appropriate for particular proposals.

****

FORM A

SOLICITED PROPOSAL APPLICATION FOR SPACE LIFE SCIENCES IN RESPONSE TO ANNOUNCEMENT #________________________ PLEASE FOLLOW INSTRUCTIONS CAREFULLY	LEAVE BLANK NUMBER REVIEW GROUP DATE RECEIVED

1. COMPLETE TITLE OF PROJECT

2. PRINCIPAL INVESTIGATOR/PROGRAM DIRECTOR *(First, middle, and last name; degrees; position title)*

3. COMPLETE MAILING ADDRESS

4. TELEPHONE NUMBER *(area code, number, extension)* FAX NUMBER E-MAIL ADDRESS	5. CONGRESSIONAL DISTRICT (U.S. ONLY) 6. SOCIAL SECURITY # (U.S. ONLY)

7. IS THIS PROPOSAL ☐ NEW ☐ RENEWAL ☐ REVISED

8. HAS THIS PROPOSAL (OR SIMILAR REQUEST) BEEN SUBMITTED TO ANY OTHER AGENCY?
☐ No ☐ Yes IF YES, SPECIFY AGENCY AND YEAR SUBMITTED:

9. CO-INVESTIGATORS *(First, middle, and last name; degrees)*	10. CO-INVESTIGATOR'S ORGANIZATION

11. DATES OF ENTIRE PROPOSED PROJECT PERIOD	12. COSTS REQUESTED FOR FIRST 12-MONTH BUDGET PERIOD		13. COSTS REQUESTED FOR ENTIRE PROPOSED PROJECT PERIOD	
	12a. Direct Costs	12b. Total Costs	13a. Direct Costs	13b. Total Costs
From: Through:	$	$	$	$

14. APPLICANT ORGANIZATION *(Organization Name)*

15. TYPE OF ORGANIZATION (U.S. ONLY)
☐ Non Profit ☐ For Profit *(General)* ☐ For Profit *(Small Business)* ☐ Public, Specify: ☐ Federal ☐ State ☐ Local

16. ORGANIZATION OFFICIAL TO BE NOTIFIED IF AN AWARD IS MADE *(Name, title, address and telephone number)*	17. OFFICIAL SIGNING FOR APPLICANT ORGANIZATION *(Name, title, and telephone number)*

18. PRINCIPAL INVESTIGATOR/PROGRAM DIRECTOR ASSURANCE:

SIGNATURE OF PERSON NAMED IN 2
(In ink "Per" signature not acceptable.)

DATE

19. CERTIFICATION AND ACCEPTANCE:

SIGNATURE OF PERSON NAMED IN 17
(In ink "Per" signature not acceptable.)

DATE

FORM B

PROPOSAL ABSTRACT

Principal Investigator: ____

Proposal Title: ____
____

Abstract

{Prepare a brief description of the application stating the broad, long-term objectives and specific aims of the proposed work. Describe concisely the research design and methods for achieving these objectives and aims. This abstract is meant to serve as a succinct and accurate description of the proposed work when separated from this application. Limit abstract to 300 words or fewer.}

Key Words:

{Assign numbers (1- highest relevance, 3-moderate relevance) to the areas that best describe your proposed research. Choose a maximum of three areas}

___Neuroscience	___Spacecraft Systems and Hardware	___Developmental Biology
___Regulatory Physiology	___Space Suit Design	___Genetics
___Behavior	___EVA/IVA Physiology	___Plant Biology
___Human Factors Studies	___Radiation Biology	___Molecular Biology
___Skeletal System	___Cell Biology	___Reproductive Physiology
___Muscle Physiology	___Radiation Physics	___Immunology
___Air/Food/Water Regeneration	___Cardiopulmonary Physiology	___Other ______________________

FORM C

SPACE FLIGHT EXPERIMENT SUPPLEMENTARY APPLICATION FORM

The following form should be completed by all investigators proposing flight experiments. This form should be inserted into the Project Description section of the proposal. (Provide responses on additional sheets, as necessary.)

Principal Investigator ____

Proposal Title ____

Type of Flight Experiment: ___Short Duration ____Long Duration ___Pre/Post-Flight

(1) If humans are required as subjects for the proposed investigation, please list
  a) number of subjects
  b) special subject restrictions, such as specific dietary regimens or fluid intake regulation
  c) special experiment protocols, such as specific work/rest cycles or exercise
  d) physiological variables to be measured.

(2) If non-humans are required for the proposed investigation, please list
  a) scientific name of species and common name
  b) gender, strain, age, stage, and weight (if applicable)
  c) minimum number required, desired number, and a rationale for both
  d) special requirements for maintenance or manipulation of the specimens.

(3) List major hardware items required in this investigation. Hardware items are listed in the document titled "*Standard Companion Document for Space Life Sciences, 1996*".

(4) Estimate access time
  a) Is late access needed and when (i.e., do you need to load the experiment and/or species within a certain time period before a launch?)?
  b) Is early removal needed and when (i.e., do you need to remove the experiment and/or species within a certain time period after landing? If so, please specify requirement.)?

(5) Identify potentially hazardous materials, including biowaste.

(6) Are there any specific conditions requested, such as air composition, humidity, temperature control, or illumination?

(7) For Space Station experiments, estimate the maximum and minimum number of days of microgravity exposure required.

(8) Estimate the total set of operations required to carry out the experiment in space (e.g., the number of sessions of crew activity and the time required for each session).

(9) Estimate amount of time for crew participation with experiment before, during and after flight (e.g., data collection, crew training, etc.)

****

Responses (continue on additional sheets):

FORM D

CHECKLIST FOR PROPOSERS

The following Checklist should be enclosed with the transmittal letter and annotated to indicate that the stated items have been included in the proposal package.

Principal Investigator/Program Director ____

_____	Form A: Solicited Proposal Application*	_____	Facilities and Equipment
_____	Form B: Proposal Summary	_____	Supporting Budgetary Information (include current support: list of other funded projects)
_____	Form US-2: Detailed 12 month Budget (First year of support)	_____	IRB or ACUC letter/ form regarding protocol approval, if applicable*
_____	Form US-3: Summary Budget Form	_____	Form US-4: Certification Regarding Drug-Free Workplace*
_____	Title Page	_____	Form US-5: Certification Regarding Debarment, Suspension, and Other Responsibility Matters*
_____	Project Description	_____	Form US-6: Certification Regarding Lobbying*
_____	Form C: Space-Flight Exp. Supplementary Information, if applicable	_____	Appendices, if any
		_____	20 copies of all material listed above
_____	Management Approach	_____	3.5 inch computer diskette
_____	Personnel, CVs; Biographical Summaries		

*One signed original form required.

Only one copy of the following materials needs to be submitted:

_____ Transmittal Letter

_____ Form D: This checklist indicates all items have been enclosed

FORM E
MULTINATIONAL **SPACE STATION**
HUMAN RESEARCH INFORMED CONSENT*

1. I, the undersigned, do voluntarily give my informed consent for my participation as a test subject in the following research study, test, or investigation:

NAME OF INVESTIGATION____

____

MISSION TO WHICH ASSIGNED ____

PRINCIPAL INVESTIGATOR____

RESPONSIBLE PROJECT SCIENTIST____

I understand or acknowledge that:

(a) This procedure is part of an investigation approved by participating agencies.

(b) I am performing these duties as part of my employment with___________________________.

(c) This research study has been reviewed and approved by the Multinational Review Board (MRB) which has also determined that the investigation involves ________________________ risk to the subject.
(minimal or reasonable)

(d) Definitions:
"Minimal risk" means that the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

"Reasonable risk" means that the probability and magnitude of harm or discomfort anticipated in the research are greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests, but that the risks of harm or discomfort are considered to be acceptable when weighed against the anticipated benefits and the importance of the knowledge to be gained from the research.

(e) The research procedures were explained to me prior to the execution of this form. I was afforded an opportunity to ask questions, and all questions asked were answered to my satisfaction. A layman's description was provided to me.**

(f) I consider myself physically and mentally qualified to participate in the investigation.

(g) I know that I can refuse to participate in the tests at any stage of their performance, and my refusal will be honored, except in those cases when, in the opinion of the responsible physician, termination of the tests could have detrimental consequences for my health and/or the health of the other subjects. However, understanding the significance of the investigations (tests), I will give every effort to perform the full scope of the program.

(h) In the event of injury resulting from this study, I understand that I will receive medical attention and necessary treatment. I also understand that I will be compensated for any injuries to the extent permitted under current _(TBD)_ and the provisions of the contract between _(TBD)_. My agreement to participate shall not be construed as a release of _(TBD)_ or any third party from any future liability which may arise from, or in connection with, the above procedures.

(i) Consistent with statutory and Agency-approved routine uses under the _(TBD)_, the confidentiality of any data obtained as a result of my participation as a research subject in this study shall be maintained, so that no data may be linked with me as an individual. However, if a “life-threatening” abnormality is detected, the investigator will notify me and the _(TBD)_. Such information may be used to determine the need for care or medical follow-up, which, in certain circumstances, could affect my professional (flight) status.

____

Test Subject Date

2. I, the undersigned, the Principal Investigator of the investigation designated above, certify that:

(a) I have accurately described the procedure and related risk(s) to the test subject.

(b) The test setup involves ________________________ risk to the test subject as determined by the MRB. (minimal or reasonable)

(c) All equipment to be used has been inspected and certified for safe and proper operation.

(d) The test subject is qualified to participate in my experiment protocol.

(e) The test protocol has not been changed from that originally approved by the MRB.

____

Principal Investigator Date

Concurrence:

____

Project Scientist Date

Notes:
* This form is valid for the period including preflight, in-flight, and postflight data collection sessions for the mission. Before the first baseline data collection, the Principal Investigator will repeat the briefing concerning risks involved in the investigation. A signed, dated copy of this form with attachments must be forwarded to Chair, Multinational Review Board.

** A detailed description of the investigation will be attached to this consent form. The Principal Investigator is responsible for formulating this document, which should be in layman’s terms such that the subject clearly understands what procedures will be required and the risks associated therewith. The detailed description of the research procedures must specifically list the risks associated with the procedures to be employed, the possible adverse reactions of all medications to be administered, and the risks/hazards resulting from exposure to ionizing radiation. Further, the investigator must clearly specify all forms of subject behavior interdicted by the research protocol (exercise, diet, medications, etc.).

****

FORM US-1

PROGRAM APPLICABILITY

Principal Investigator: ____

Co- Investigators: ____
____
____

Proposal Title: ____
____

Proposal Type:

SCIENTIFIC PROPOSAL____
OR
TECHNICAL PROPOSAL____

GROUND-BASED RESEARCH _____
OR
SPACE FLIGHT EXPERIMENT_____

{Place a single check in the "Primary Area" column next to the program that is most closely aligned with your proposal. Optional: Place a check in the "Secondary Area" column **if** your proposal has a dual-program emphasis}

	Primary Area	Secondary Area
GRAVITATIONAL BIOLOGY	_____	_____
SPACE PHYSIOLOGY	_____	_____
ENVIRONMENTAL HEALTH	_____	_____
SPACE RADIATION HEALTH	_____	_____
BEHAVIOR & PERFORMANCE	_____	_____
ADVANCED TECHNOLOGY DEVELOPMENT	_____	_____
SPACE HUMAN FACTORS ENGINEERING	_____	_____
ADVANCED LIFE SUPPORT	_____	_____
ADVANCED ENV. MONITORING & CONTROL	_____	_____

FORM US-2

PRINCIPAL INVESTIGATOR/PROGRAM DIRECTOR: ____________________

DETAILED BUDGET FOR 12-MONTH BUDGET PERIOD **DIRECT COSTS ONLY**	FROM	THROUGH

Duplicate this form for each year of grant support requested

DOLLAR AMOUNT REQUESTS *(Omit cents)*

PERSONNEL *(Applicant Organization Only)*

NAME	**ROLE IN PROJECT**	**EFFORT ON PROJECT**	**SALARY**	**FRINGE BENEFITS**	**TOTALS**
	Principal Investigator				
	SUBTOTALS →				

CONSULTANT COSTS	
EQUIPMENT *(Itemize, use additional sheet if needed)*	
SUPPLIES *(Itemize by category, use additional sheet if needed)*	
TRAVEL — DOMESTIC	
TRAVEL — NON-DOMESTIC	
OTHER EXPENSES *(Itemize by category, use additional sheet if needed)*	
TOTAL DIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD ***(Item 12a, Form A)***	**$**
INDIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD	**$**
TOTAL COSTS FOR FIRST 12-MONTH BUDGET PERIOD ***(Item 12b, Form A)***	**$**

FORM US-3

PRINCIPAL INVESTIGATOR/PROGRAM DIRECTOR: ______________________

BUDGET FOR ENTIRE PROJECT PERIOD DIRECT COSTS ONLY

BUDGET CATEGORY TOTALS		1st BUDGET PERIOD	ADDITIONAL YEARS OF SUPPORT REQUESTED		
			2nd	3rd	4th
PERSONNEL (Salary and Fringe Benefits) (Applicant organization only)					
CONSULTANT COSTS					
EQUIPMENT					
SUPPLIES					
TRAVEL	DOMESTIC				
	NON-DOMESTIC				
OTHER EXPENSES					
TOTAL DIRECT COSTS FOR EACH BUDGET PERIOD		**$**	**$**	**$**	**$**
TOTAL INDIRECT COSTS FOR EACH BUDGET PERIOD		**$**	**$**	**$**	**$**
TOTAL DIRECT + INDIRECT COSTS FOR EACH PERIOD		**$**	**$**	**$**	**$**
TOTAL DIRECT + INDIRECT COSTS FOR ENTIRE PROJECT					**$**

JUSTIFICATION FOR UNUSUAL EXPENSES (Detail Justification in Cost Section of Proposal)

CERTIFICATION REGARDING DRUG-FREE WORKPLACE REQUIREMENTS

ertification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulatic hed in the January 31, 1989 Federal Register, require certification by grantees, prior to award, that they will maintain a drug-free workplac ertification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the gr certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or governm suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620).

ANTEES OTHER THAN INDIVIDUALS

The grantee certifies that it will provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlle substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of suc prohibition;

(b) Establishing a drug-free awareness program to inform employees about --

(1) The dangers of drug abuse in the workplace;

(2) The grantees policy of maintaining a drug-free workplace;

(3) Any available drug counseling, rehabilitation, and employee assistance programs; and

(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee

(1) Abide by the terms of the statement; and

(2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days aft such conviction;

(e) Notifying the agency within ten days after receiving notice under subparagraph (d) (2) from an employee or otherwise receiving actu notice of such conviction;

(f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d) (2), with respect to any employee w so convicted --

(1) Taking appropriate personnel action against such an employee, up to and including termination; or

(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such pur by a Federal, State, or Local health, Law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e), (f).

The grantee shall insert in the space provided below the site(s) for the performance or work done in connection with the specific grant:

of Performance (Street address, city, county, state, zip code)

____

____

____

____

____ if there are workplaces on file that are not identified here.

RANTEES WHO ARE INDIVIDUALS

rantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possessio a controlled substance in conducting any activity with the grant.

____

ization Name AO or NRA Number and Title

____

d Name and Title of Authorized Representative

____

ure Date

____

d Principal Investigator Name Proposal Title

FORM US-5

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS PRIMARY COVERED TRANSACTIONS

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participants' responsibilities. The regulations were published as Part VII of the May 28, 1988 Federal Register (pages 19160-19211). Copies of the regulations may be obtained by contacting the U.S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, S.W. (Room 3633 GSA Regional Office Building No. 3), Washington, D.C. 20202-4725, telephone (202) 732-2505.

A. The applicant certifies that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this application been convicted or had a civil judgement rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

C. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lowered Tier Covered Transactions (Subgrants or Subcontracts)

(a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any federal department of agency.

(b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

____

Organization Name   AO or NRA Number and Title

____

Printed Name and Title of Authorized Representative

____

Signature   Date

____

Printed Principal Investigator Name   Proposal Title

FORM US-6

CERTIFICATION REGARDING LOBBYING

As required by S 1352 Title 31 of the U.S. Code for persons entering into a grant or cooperative agreement over $100,000, the applicant certifies that:

(a) No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant or cooperative agreement;

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, an or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants and cooperative agreements, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

____

Organization Name AO or NRA Number and name

____

Printed Name and Title of Authorized Representative

____

Signature Date

____

Printed Principal Investigator Name Proposal Title